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SCIENCE, founded in 1880, is published each Friday by the American Association for the Advancement of Science at Business Press, Lancaster, Pa. Entered at the Lancaster, Pa., Post Office as second class matter under the Act of 3 March 1879.

SCIENCE is indexed in the *Reader's Guide to Periodical Literature* and in the *Industrial Arts Index*.

Editorial and personnel-placement correspondence should be addressed to SCIENCE, 1515 Massachusetts Ave., NW, Washington 5, D.C. Manuscripts should be typed with double spacing and submitted in duplicate. The AAAS assumes no responsibility for the safety of manuscripts or for the opinions expressed by contributors. For detailed suggestions on the preparation of manuscripts, book reviews, and illustrations, see *Science* 123, 714 (27 Apr. 1956).

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Society in the Scientific Revolution

The recent political campaign for the Presidency of the United States was noteworthy for the initial appearance of a technical issue as a major feature. The problem of radiation hazard and its relation to tests of the H-bomb became a political football, but the game appears to have ended with the political campaign.

This situation is a symptom and a result of a new social revolution, the Scientific Revolution, even greater in its effect than the Industrial Revolution. The health, longevity, comfort, and security of mankind already have been markedly affected by the application of scientific discoveries and information. Much greater changes seem imminent in the near future and at a continually accelerated pace.

The new revolution can be the source of good or evil, according to the use made of these discoveries and to the facility with which society and science recognize and adjust to the changing conditions. The proper functioning of the democratic process could greatly ease the tensions and requires that society give both the natural and the social sciences a place in its councils at all levels of the social structure. In turn, scientific organizations may be obliged to accept a social responsibility commensurate with the importance of the social effect of science.

These conclusions are some of those indicated by the Interim-Committee on the Social Aspects of Science, authorized by the AAAS Council in December 1955 at Atlanta, Georgia. They are contained in a provisional report entitled "Society in the Scientific Revolution," which has been distributed to council members. A companion resolution will be presented at the coming council meeting.

The committee believes that society and science are now so intermeshed and interacting that scientific groups must reevaluate their traditional "isolationist" positions and accept the place in the democratic process demanded by the current importance of science.

The matter is deeply serious and involves a profound change in the attitudes and actions of both scientists and nonscientists. The committee requests that AAAS councilors give adequate consideration to the report prior to the council meeting and that the subject be one for profound consideration and discussion by all interested persons. Comments should be sent to the members of the committee in time to be considered before the council meeting.

The report is being submitted with a full realization of its inadequacies but with the belief that these problems must be debated by all citizens, especially scientists.—INTERIM-COMMITTEE ON THE SOCIAL ASPECTS OF SCIENCE: BARRY COMMONER, GABRIEL LASKER, CHAUNCEY D. LEAKE, BENJAMIN WILLIAMS, WARD PIGMAN (*chairman*)

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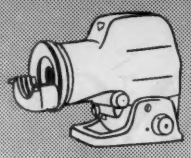
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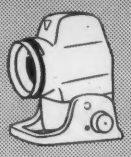
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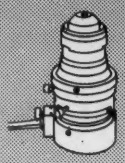
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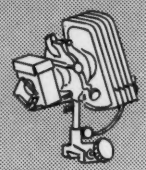
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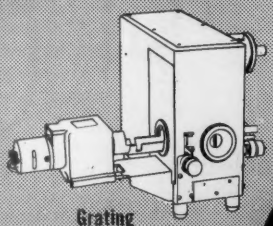
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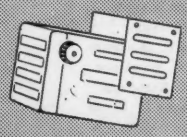
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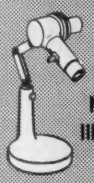
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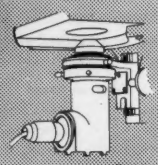
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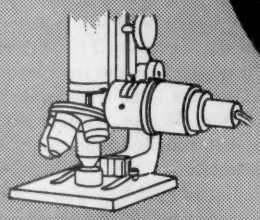
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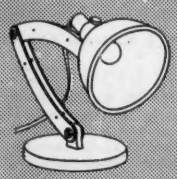
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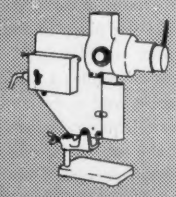
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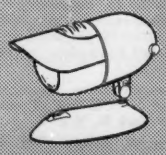
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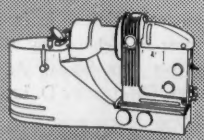
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21 December 1956, Volume 124, Number 3234 SCIENCE

Why Biophysics?

A. V. Hill

The title chosen for this article, "Why biophysics?," suggests an inquiry into what role a particular branch of science, one which only recently acquired a name and personality, can play in medical progress and practice. Looking through the titles of this series (*Lectures on the Scientific Basis of Medicine*) in the last 5 years one finds that, whereas a large proportion are obviously derived from physiology or biochemistry, very few could reasonably be called biophysics—even if one includes a lecture by the president of the Royal College of Physicians on "Mind and matter"! This is natural and proper, for physics hitherto has not had the same intimate connection with medicine that physiology and chemistry have had: its applications have rather been to engineering, while its ideas have been derived not at all from biology but from mathematics, astronomy, and philosophy. It is true that physical ideas and physical instruments and methods are fundamental to nearly all fields of science; but it is only in recent times that separate branches of physics have been recognized in which the primary object was not physics itself but some other subject—for example, astrophysics aiming at the problems of astronomy, geophysics at those of the earth, physical chemistry at those of chemistry, and now biophysics at those of biology. Chemistry also has proliferated—into geochemistry, biochemistry, and a host of practical applications, the object of which is not the solving of purely chemical problems but the use of chemical ideas and methods for understanding, or doing, something else.

Biophysics is a newcomer; so was biochemistry 40 to 50 years ago. This does not mean that chemistry was not applied to biology and medicine long before, in fact chemistry and medicine grew up together; but it does mean that biochemistry began clearly to emerge as a separate and independent discipline, with its own ideas and methods, early in this century. It is unnecessary to insist that biochemistry is not just chemistry; to take the biological idea out of it would be like depriving a man, not of his clothes, but of his skin—he might be an interesting object of study, but he would cease to be a man. In the same way biophysics is not just physics, but a sturdy and promising child of physics and biology which has set out on the same road of independence as biochemistry did 40 or 50 years ago.

The idea of function, of organization, of design, is an essential part of biology as it is of engineering; in physics and chemistry, apart from their applications which are really engineering, it is meaningless. Whatever his philosophical or theological views, it is sensible and expedient for a physiologist, using that term in the wider sense, when investigating an organ, a structure, a response or an adaptation, to ask what its functional significance is, its relation to other parts of the machinery, its purpose in connection with behavior, survival, or inheritance. If his conscience, or his politics, forbids that much teleology, he had better take up something else; for in biology he will miss most of what is interesting. The biochemist is not merely a chemist working at the chemistry of material that was once alive or was produced by living activity; he is primarily concerned with processes that go on within the living organism and their dynamic connections with function or behavior. The comparative study of animals from the functional standpoint turns up innumerable examples of what any engineer, faced with them, would assume to be highly competent design—and botanists surely would insist that the same is true of plants. After all, evolution has been at work for a very long time, and we cannot neglect its consequences.

What Is Biophysics?

The term *biophysics* is coming today into common use, but as yet no clear definition of it has emerged. The emphasis must clearly be on the *bio*, on function and structure viewed through physical spectacles and investigated by physical ideas and methods. The word *definition* implies setting limits, and it is convenient to start defining biophysics by reciting many things which it is not. One thing it clearly is not is a second-rate branch of physics, a haven of refuge for indifferent physicists. It does not consist of teaching physics to medical students. It is just as unsuited—and some may think this a hard saying—to people who know no biology as to those who know no physics. It does not consist of constructing, or maintaining, physical equipment for use by anatomists, biochemists, physiologists, or clinicians. The employment of physical instruments in a biological laboratory does not make one a biophysicist—otherwise any user of a microscope, a balance, an x-ray equipment, a Geiger counter, or a *p*H meter, would drop automatically into that class. The crystallography of material of biological origin is not in itself biophysics, any more than organic chemistry is biochemistry. Using amplifying values or radioisotopes, or working on muscles and nerves, does not confer any biophysical status. It all depends on the motive, on the idea, on the method and manner of approach.

Science does not operate only in separate compartments of knowledge, and many of the best discoveries emerge from

Dr. Hill, a Nobel prize winner in physiology and medicine, was formerly Foulerton research professor of the Royal Society at University College, London. He resides at 16 Bishopswood Road, London, N. 6. This article is based on a lecture given at the British Postgraduate Medical Federation on 19 Oct. 1954. It was the first of a series of 30 lectures, which were published in *Lectures on the Scientific Basis of Medicine, 1954–55*, vol. 4 (Athlone Press, London; John de Graff, New York, 1956) and is reprinted here by permission.

the borderland between several of them. One reason, however, for adopting a new name or inventing a new organization may be to find room for people whose special knowledge or talents cannot fit into the accepted scheme. The growth and recognition of biochemistry made it possible for people trained first in the discipline of chemistry to work in the biological field, on equal terms with those coming from medicine or biology. Few of these would have found a home and opportunity in laboratories of physiology, anatomy, pharmacology, or pathology, where most appointments were by tradition, and still are, reserved for medical graduates. Few of them could have established themselves in laboratories of zoology or botany, the scale and scope of which were usually too small. In the end it was better so, for biochemistry has emerged as an adult subject, asking nobody's leave to work at any of the problems of biology by chemical methods and with chemical ideas. Today, 40 to 50 years later, the same course is being followed by biophysics.

For some time now, and particularly since the recent war, an important number of young physicists have got hold of the notion that some of the most fruitful outlets for physical ideas and methods are likely to be found in biology. Perhaps this is partly due to a reaction against the aggressive dominance of nuclear physics and a reluctance to become a cog in that particular machine; partly, I am sure, it has been that biophysics offered scope to adventurous and adaptable minds. Another reason, probably, was the resource and initiative with which many young biologists mixed up with physicists, in telecommunications and in operational research, and the like, during the war.

In biology one has to live by one's wits, competing as in a game with living material which is always to some degree unpredictable; one does not have to go humbly to a theoretical biologist to plan the strategy of one's research. This tends to produce a quick response to the unexpected—which is useful in war and very often in research. Contact with such people may have given some young physicists an impression that biology, after all, can be quite a respectable subject, with many exciting problems waiting to be tackled by new and adventurous methods. It has even come about that eminent professional physicists are ready today to admit the interest and difficulty of biological problems and the intellectual and experimental skill required for tackling them. That was not always so, and again the analogy with biochemistry is apt.

At one time the professional chemist was likely to regard biochemistry as a nasty messy subject, not worthy of his distinguished attention. Today many of the leaders of chemistry are working in fields that verge on biochemistry—indeed to such an extent that some of them would like to appropriate the subject as their own, and biochemists have had obstinately to maintain their identity against the acquisitive dominance of chemistry. Out of the frying pan into the fire might have been the fate of biochemistry when it got away from physiology.

For many years physicists and mathematicians have been among my closest friends, and one of my functions has been to keep them humble by reminding them now and then that other subjects than theirs are intellectually quite as respectable, experimentally much more difficult, and generally far more amusing. The simplified problems of physics require only a small part of one's thinking apparatus, used no doubt very intensively; those of biology demand a much greater share of one's resources. Today my friends are more respectful; naturally they do not like their best pupils leaving them to go off into biophysics, but at least they do not regard such defection as an irretrievable disaster to science!

It would be a damaging mistake, however, to suppose that physics, in the narrower sense, is the only partner of biology in the new field of biophysics. Most vital processes take place in an aqueous medium, in which chemists are much more at home than physicists. There is no sharp boundary between chemistry and physics, nor should there be between biochemistry and biophysics. The natural division, in general, would be for biological problems involving physical chemistry to be drawn toward biophysics, as those involving organic chemistry would go to biochemistry. The physical chemists who turn over to biophysics may be expected to make at least as great a contribution as the physicists proper. With nuclear physics, as such, which tends at present to dominate physics, biology is little concerned. Biological processes are based on molecular change, and only to the extent that the chemistry of molecules is determined or affected by the physics of their atoms does the latter impinge directly on the interests of biologists. Indirectly, of course, by the tools it provides and the effects of its products, nuclear physics is of the greatest concern to biologists—as it is to everybody; but the fact remains that vital processes themselves, to an overwhelming extent, are more of a chemical, or a physicochemical, than of a purely physical character. Indeed, without physical chemistry as an essential component in its make-up, biophysics would have little reason for a separate existence.

Twenty-four years ago I addressed a gathering in Philadelphia, at the opening of a new laboratory of Medical Physics, of which my friend D. W. Bronk was head. Much good work, largely of a new scientific flavor, has come from that laboratory. Twenty years later I took part in the opening at Johns Hopkins University of another new laboratory of biophysics, also organized by Bronk. In the United States today there are many departments of biophysics, not always under that title, in which physical ideas and methods are being applied to biological problems. The great developments of nuclear physics in America, as in England to a somewhat smaller extent, have led to a large expansion of what can be called radiobiology: this is aimed partly at the protection of the human body from the effects of radiation, partly at improvement of medical treatment, but partly also at solving the fundamental scientific problem of how radiation of various kinds affects living cells, their functioning and inheritance. This, however, is only one aspect of biophysics; another important one is the study of the minute structure of living cells, which is being pursued in America, for example, at F. O. Schmitt's laboratory at Massachusetts Institute of Technology, and in London in Randall's laboratory at King's College. Three years ago the first regular university department of biophysics in England was started at University College. But let nobody suppose that biophysics is being pursued only in such regular departments of the subject; far from it—there are individuals and groups working at it in many laboratories and centers, in England and other countries, under many titles.

It is not at all necessary that there should be departments of biophysics in every university—any more than there should be of biochemistry; the important thing is that a few such departments should be established, to act as nuclei for teaching and research and to give the subject a place on the map, a personality and status which will draw young people of the right kind into its pursuit. The process has started well and can be left to develop largely of itself, with sympathetic help but without too much overhead planning. One need not advocate, for example, that there should be an international union, or international congresses, of biophysics; it can safely find its scope, at least for a long time yet, within those of physiology, biology and biochemistry.

With all these qualifications about what biophysics is not, may I try to define what it is: as the study of biological function, organization, and structure by physical and physicochemical ideas and methods. There is nothing very interesting or original about that; except perhaps the fact that ideas are put first, for physical methods and instruments of every kind may be used in any field of research. Biological phenomena, like many others,

show aspects and relations susceptible of physical analysis and interpretation. It is by the choice of problems and by the intellectual processes with which they are formulated and attacked, more than by the particular techniques employed, that a subject can be most clearly defined. There are people to whom physical intuitions came naturally, who can state a problem in physical terms, who can recognize physical relations when they turn up, who can express results in physical terms. These intellectual qualities, more than any special facility with physical instruments and methods, are essential to the make-up of a biophysicist. Equally essential, however, are the corresponding qualities, intuitions, and experience of the biologist. A physicist who cannot develop the biological approach, who has no curiosity about vital processes and functions, who is not willing to spend time in learning the habits of living things, who regards biology simply as a branch of physics has no important future in biophysics.

In speaking of the intellectual side of the physical approach to biology you must not suppose that I underrate the technical side or imagine that theoretical physics has more than an occasional role at present to play in biology. So far, indeed, from underestimating fine physical techniques applied with the skill and understanding that come from experience in handling living material, one would insist rather that progress is waiting on their application, and that biological literature is beset by the results of imperfect experimentation. I am urging only that the primary condition is the right intellectual approach. Granted this condition, achievement can come only by highly skilled and often laborious experiments, laborious because of the essential lability of the material. In such experiments the instruments and methods must often be adapted to the object investigated, so that the principles of their design and working must be understood. When one is dealing with units of extremely small size like living cells, personal skill becomes of primary importance. It cannot usually be replaced by statistical methods, important as these are in their proper place. The chief concern in the development of biophysics is that those skills should be acquired by people who start with the right intellectual approach, physical and biological.

Let us think for a moment how the process of investigation goes. In the function or structure to be studied, some factor is chosen which not only is open to physical description or attack by physical method but also, if so treated, may lead to unambiguous results. It is all too easy —and frequent—to make beautiful experiments which cannot, in any case, tell us anything, or perhaps may tell us about something in which we are not interested. I recall experiments that purported to measure the elasticity of muscle but gave in fact, rather inadequately, the constant of gravitation; others that were intended to verify a particular theory of colloid behavior really proved nothing except the second law of thermodynamics. It is all too easy to employ fashionable physical devices for purposes better achieved by simpler traditional methods. For example, some years ago, an old-fashioned gas regulator with a tapered jet was found to beat all the best electronic devices of its day for maintaining a constant temperature in a water bath.

The use of the latest physical methods and devices does not make one a physicist, and the employment of such things in a biological laboratory is not necessarily biophysics. The man who has physical ideas, who can see physical problems, who recognizes the opportunity of physical investigation when it turns up, who understands and can use physical techniques can find unlimited opportunity in biology, if—and it is a fundamental *if*—he is willing to learn something also of the facts and philosophy of biology, to be apprenticed for a time in a biological workshop. Some of the most accomplished contributors to what is really biophysics, though it may be practiced in laboratories under other names, started in fact as biologists; and a complete department of biophysics really requires both kinds—with a reasonable admixture of engineers!

Relation of Biophysics to Biochemistry

In one important respect the roles of biophysics and biochemistry are complementary. The single unit in biology, the living cell, is very small; the quantities involved in its processes are beyond the range of ordinary chemical measurement. It is necessary therefore to use large numbers of cells, similar as far as possible, and to accept a statistical blurring of the result. For biophysical purposes, however, it is frequently possible to use single cells and to examine the individual process, with the limitation always that most physical methods are chemically nonspecific, so that interpretation in chemical terms is bound to be indirect. In biochemistry, even accepting the necessity of working with a large number of cells, there are two further limitations; its methods are usually insensitive and very slow, and many of them require the destruction of the tissue for their application. The astonishing thing is that biochemistry has, in fact, been able to achieve so much. In comparison, the methods of biophysics may be very sensitive and rapid and often leave the tissue unaltered so that observation can be continued; but they are not applicable to all problems and—one must insist—they are nearly always chemically unspecific.

Let us illustrate the contrast between biochemistry and biophysics by the example of muscle. Here the fundamental unit of response is the single muscle twitch, a very rapid affair involving only a minute chemical change. Physical methods are available of high sensitivity and speed which can give a quantitative picture, practically simultaneous with the events themselves, of electrical, optical, mechanical, and thermal changes accompanying a twitch. Direct chemical methods, however, can tell us nothing; in order to get measurable quantities it is necessary to subject the muscle to a sequence of stimuli spread over a longer interval. If it were possible to assume that a single chemical process was involved in muscular activity, that it went in one direction only and was not rapidly reversed, one might calculate that the chemical effect of 40 twitches was simply 40 times the effect of one twitch. In fact, however, the finer details of the complex sequence of chemical events are confused by repeating the stimulus many times; only the final or semifinal effects are accumulated. To take a simple example, the immediate physiological and biochemical consequences of running 20 meters at top speed would not be discovered at all by making a man run 2 kilometers as fast as possible and dividing the observed changes by 100.

This difficulty of examining chemically the ultimate physiological events is widespread, in nerves, in muscles of all kinds, in the central nervous system, in all tissues in fact in which activity occurs in small discrete packets, rather than continuously. This still leaves available for biochemical study a variety of tissues in which activity is apparently continuous; but such tissues usually get into a steady state, in which the total metabolic effect over an interval is all that is measured; and the unraveling of intermediate processes has always been one of the greatest problems and has led to the greatest scientific achievements of biochemistry. In muscle, with its high rate of chemical turnover and the rapid changes and reversals involved in its unit of activity, our chemical knowledge has largely been derived from studies of isolated enzyme systems and chemical constituents. But this knowledge cannot be extrapolated backward, without confirmatory evidence, to describe the actual chemical events of contraction. Such evidence can come only from methods of much higher speed and sensitivity than chemical technique is yet endowed with.

But—let us admit it humbly—to attempt to solve the problem by physical methods alone would be just as fantastic. Ultimately the machinery itself is chemi-

cal in nature, the fuel it uses for its recovery process is chemical, the "acid" and the "plates" of its "accumulators" are chemical, the free energy of chemical change provides the mechanical work, and various enzymes prescribe the course of the reactions. No physical methods conceivably available could give us the specific chemical information required to solve the problem properly. It is natural and healthy that biochemist and biophysicist should tease each other sometimes about the limitations of the other's methods: but each should be keenly aware of the limitations of his own and seek the cooperation which alone can solve their common problems. And perhaps it would be wise for them both to reflect, when they think they have solved them, that the biologist can still point out that although they may have found out how the machinery works—if indeed they have—this is very far from answering the question of how it grew and developed, how it maintains and adjusts itself, how its design is so singularly well-adapted to the needs and purposes of its owner.

Philosophy of Biophysics

On that occasion in Philadelphia in 1930 I spoke on the rather cryptic title "The physical reasonableness of life"; it allowed me to expound a faith that no limit will be found at which the application of physical methods and ideas—and, of course, this implies chemical ones, too—will be forced to stop in the investigation of living processes. I was at pains to emphasize that this certainly does not imply that biology will finally become simply physics and chemistry—at least as one knows those subjects now; indeed, the boot is rather on the other leg, physics and chemistry have in the end a great deal to learn from biology, in their philosophy and ideas as well as in their opportunities for research.

It is obvious indeed, at least to those biologists who know something about the properties of the nervous system, that physical theories and concepts can have no absolute validity apart from the brains that conceive and use them; if they *can* be conceived by the brain, it seems most unlikely that their pattern is not conditioned, and to some degree determined, by the properties and machinery of that organ. What we know of the working of brain and nervous system is largely the result of the application of physical, particularly of electrical, methods; perhaps, in the future, communication theory will make its contribution, and that is a mathematical branch of engineering. But if we assume that a consistent theory of the natural world is ultimately possible, we have to admit that just as scientific instruments and engineering appliances are designed to fit the human senses and faculties that employ them, so scientific theories have to be made to fit the human brain that uses them.

My physical friends are often rather indignant at any such idea; they have been brought up to believe that their postulates have some virtuous kind of absolute reality. The history of science scarcely bears out so naive an assumption; and when we know more about the mechanism of the brain I think we shall begin to see how it determines the pattern of any physical theory which it is humanly possible to conceive. This expectation accompanies an uncompromising conviction that the methods and ideas of the physical sciences are an unconditional necessity for biological progress; but it is part of an equally firm conviction that biology is not in the least danger of being swamped or subjected in the process. Physics and chemistry will dominate biology only by becoming biology. We can live in hope of the future unification of biological and physical science—but need not fear at all the dreadful prospect that life will be explained away in terms of present-day physics and chemistry.

It would be possible to make a number of platitudinous remarks about physics as a necessary ingredient in the training of a modern physician. So far as these were true they would mostly be obvious, and if they were not obvious they would probably be false. The important thing to remember is that even medical students are human. In India in 1944, in reply to pressing invitations from Indian friends which I should have loved to accept, I had often to insist that even a physiologist cannot be in more than two places at once. A similar limitation applies to medical students.

A few years ago I was temporarily involved with the problem of load carrying by the infantry soldier. In given circumstances, for a given individual there is an optimum load. With much less he will march and fight better—for a time—but soon he will have no food and water to march on, no weapons or tools to fight with. With much more load, he will march and fight worse, however well fed and armed. It is the same with the modern medical student: the poor boy, or girl, has a terrible load to bear anyhow and if you pile too much upon him (there is no danger of giving too little) you will make him unable to do the educational equivalent of fighting, namely, to think, criticize, and discuss. For this reason, much as we should like him to know more physics, chemistry, and mathematics, more biology, physiology, and anatomy, before we let him loose on his clinical course—much indeed as we should prefer him also to know more of literature, philosophy, and sociology and to have a wider culture and experience—we must think of him, like the poor infantryman, as having an optimum load which it is improvident to exceed. This load, as with the soldier, has to be the same for all, so it must be within reason for the weaker individuals, which means that the stronger ones could carry more. The extra physics, or the extra biology, or the extra culture and experience, must be regarded as an extra for those who can bear that particular burden easily enough. We must in fact provide opportunities outside the regular curriculum for the more talented students to follow their natural bents. It would be the greatest misfortune if biophysics or biochemistry were to draw no recruits from medicine.

It needs no argument to show that physics and chemistry—or even mathematics in the special form of statistics—impinge every day on medicine and public health. It is essential that every physician should have this much acquaintance with them that he knows, first, where to turn for help, whether to technician, specialist, manufacturer, or librarian, and, second, and even more important, not to be taken in by magic masquerading as science. In every field of medical science, and of medicine, we are witnessing the impact of chemistry and physics: on ways of looking at things, on research, on diagnosis and treatment. Indeed, the very nature of our modern society, based as it is on engineering applications of the physical sciences, is bringing a host of new problems, as well as of methods and equipment, to human biology and medicine. Indeed, these applications of the physical sciences are providing some of the major problems which the world has now to face, problems which human biology and medicine can neglect only at their peril. The question is—what are we going to do about it, in connection with medical education? The last thing one would want to do is to overemphasize—as the public is apt to do—the place and importance of the physical sciences. We have to realize that the calling of the good physician requires every faculty of critical intelligence and knowledge, of sympathetic understanding, of skill and patience, that a human being can possess. In planning his education we must aim at a practicable optimum, not an impossible ideal, and this means a sensible compromise between all the things he has to learn and do, taking good care that he has time and energy enough left over to grow as well as to be planned.

For some years, though a very long time ago, I was responsible for teaching physiology to medical students, and I frequently asked myself—and they asked me—what was the good of this or that? Most of them would have little direct

use for many of these things in later life. Might not time saved in such irrelevant studies allow them to acquire a little more personal skill in handling patients—which could serve them and the patients better. Such queries might seem particularly pertinent in respect of the physical sciences in the premedical curriculum. There are many answers to such a question, most of which are well known. It is unnecessary to emphasize that physics and chemistry are an essential background today to the biological sciences, that these are fundamental to medicine, or that physical and chemical methods of diagnosis and treatment make up a large part of modern medicine. One has, rather, to answer the objection that within the very limited load a medical student can bear there can be so little given him of each of these preliminary sciences, and that what he learns he soon forgets. Since we cannot expect him to be an expert in physics and chemistry, may not a little knowledge be a dangerous thing?

The answer I think is this, it depends on a property of the human mind, a property we all know, unconsciously perhaps, very well. Let me illustrate what I mean by personal experience. I learned quite a lot of mathematics at school and in my first 2 years at Cambridge, but I have steadily been forgetting it ever since. One's mathematical knowledge seems to have a half-life of about 3 years! But it really has not mattered much. In countless jobs I have had to do, not only in physiology or biophysics, mathematical ideas and methods have been wanted. Somewhere deep in the brain the memory has continued of what mathematical ideas feel like, of what sort of problems can be tackled by mathematical means, of how to state a problem in mathematical terms, of where to look, either in books or to people, for a solution of it. My actual knowledge of mathematics for many years has been contemptible—yet I know how much the mathematical approach continues to influence the pattern of my work. Forgive me for referring to a personal experience; I do so because it is not really personal at all but depends upon a general property of the mind. If a boy or girl has been brought up with the discipline of a mathematical, physical, and chemical stiffening to his scientific training, he will find, whatever he does and however much he forgets, that a method of thinking and acting, of criticizing and assessing facts and theories, is available to him without which much of the world is meaningless: not only of the physical but of the biological world, not only the world of our engineering environment but that of medicine, of social relationships, and of human behavior.

This sounds like a tall order, but I think it is true. It implies that mathematics and the physical sciences can provide a framework for the other sciences that are to follow; and they should be learned early. This means that scientific biology should come later, as I think it should, for scientific biology, as distinct from simple natural history, is more intelligible on a background of physical and chemical knowledge. Do not suppose that placing biology second in time means putting it second in importance. A certain amount of biology is an essential ingredient in education—even of a physicist, a politician, a parson, or an engineer! But in the case of a professional biologist—as a physician should be counted—it can be learned best if the mind is prepared already by a reasonable preliminary dose of the physical sciences. It is hard to convince a medical student when he is 20 that a course in elementary mathematics is a useful preliminary to medicine; at that stage, indeed, it probably is not! It should have come 6 or 7 years earlier. To some extent, and to a different time scale, the same is true of physics and chemistry. In a modern building the steel is no more important than the other constituents—but it is essential to put it in first.

Why Biophysics?

I have wandered from the title of this article in talking about physical science in the education of the future physician, but if biophysics is to make its contribution to medicine it is necessary that most physicians should have some idea at least of what it is about, while some physicians should have a pretty good idea. The ideas and methods of physics and of physical chemistry are being applied today and will increasingly be applied, not only directly to physical medicine and radiology, but to neurology, to the study of circulation, of respiration and excretion, and of the adjustment of the body to abnormal conditions of life and work. At longer range, moreover, they will be aimed at the fundamental problems of minute structure and organization, of the physical basis of growth and inheritance, of the ordered and organized sequence of chemical reactions in vital processes, of the means by which energy is supplied and directed to vital ends. It is inevitable today that most of the discoveries in such fields will be made by people who have not passed through the gateway of medicine; but the greatest good comes from mixing people up, so that research and development (to use an industrial term) in promising fields can be guided to practical ends. This implies that those whose ends are practical (and the aims of medicine, like those of engineering, are practical, however great their intellectual content) should be on terms of familiar equality with those whose moving force is scientific curiosity. It is necessary that each should know what the other is talking and thinking about. The physicists and the chemists must be acquainted with biology, the biologists (including the medical people) must know some physics and chemistry.

The chief answer, then, to the query "Why biophysics?" is that the recognition of biophysics as a special subject of study will emphasize the fact, and I think it is a fact, that the future of biology and medicine will increasingly require the application of physical and physicochemical ideas and methods. To give biophysics a name and personality, to endow it with a few centers where it can be specially practiced, to realize that its recognition implies much more than just mixing up biologists and physicists (good as that is) will draw in recruits to a science that in 20 years or so may have the same importance to biology and medicine as biochemistry has come to have today. I am content myself to have been a physiologist, but that was luck because Walter Morley Fletcher was my tutor at Cambridge. Others of like tastes, but without such good fortune, may not find their way in at all unless the road is open and given a distinctive name.

Stokes' Edge Waves in Lake Michigan

William L. Donn and Maurice Ewing

During the past centuries a considerable loss of life and property has been recorded in shore areas from the effects of one or a series of high water waves that appear abruptly and usually without warning. This phenomenon is common to large inland lakes, bays, estuaries, and open coastal zones. When these waves have meteorological origins, they are referred to as "storm surges"; when they are of earthquake origin, they are referred to as "tsunamis."

Large inland water bodies provide ideal places to study these waves, because water and air data may be available from the entire lake boundary as well as from the surrounding region. This is not true for a seacoast.

The disastrous Lake Michigan surge of 26 June 1954, which took a number of lives along the Chicago waterfront, has been explained by us (*1*) on the basis of resonant coupling between a fast-moving atmospheric pressure-jump line (squall line) and the resulting gravity wave generated in the lake. Reflection of this high-coupled wave from the eastern shore of the lake accounts for its unexpected arrival at Chicago about 2 hours after the squall itself passed there.

Ten days later, a new pressure-jump line crossed Lake Michigan from north to south with a speed of about 50 miles per hour. Several water-level instruments maintained by the U.S. Lake Survey, the state of Illinois, and lakeside industrial plants, recorded long-period high waves that can be correlated with the pressure-jump and appear to be explainable on the basis of the theory described in subsequent paragraphs. After a discussion of the theory, we present the new storm-surge data and the application of the theory (*2*).

Stokes' Edge Waves

The theory of long gravity waves (where $c = \sqrt{gh}$) as applied to the earlier storm surge of 26 June does not provide an adequate explanation for the new case. It does not account for the long period of the water waves, and it also seems probable that the effects of resonant coupling between the atmospheric disturbance and such gravity waves would be kept to a minimum, owing to continuous refraction of the waves toward the shore.

Recently, Munk, Snodgrass, and Carrier (*3*) explained certain wave phenomena over gently sloping continental shelves by means of the theory of edge waves, which was first described by Stokes (*4*) in 1846 and has been elaborated by Ursell (*5*, *6*) in recent years. These waves, which travel with crests transverse to the shore, are dispersive waves whose phase velocity is a function of the slope of the bottom and of the wave period. They can be thought of as resulting from the constructive interference of refracted gravity waves of different wavelengths. Such interference produces wave crests (edge waves) that maintain themselves transverse to the shore. The refraction effect confines the energy to a distance $\lambda/2\pi$ from the shore (where λ is the wavelength), so that the wave height becomes negligible at this distance.

Following Ursell (*6*), we let β be the inclination of the lake bottom and with origin at the edge, take the x-axis in the water surface normal to the edge, the y-axis downward, and the z-axis parallel to the edge. The velocity potential ϕ for waves propagating with their crests transverse to the shore must be of the form

$$\phi = A \cos(kz - \sigma t) e^{-k(x \cos\beta + y \sin\beta)} \quad (1)$$

where A is the amplitude; t is the time; λ, the wave length, is $2\pi/k$, or k is $2\pi/\lambda$; and T, the period, is $2\pi/\sigma$, or $\sigma = 2\pi/T$; in order to satisfy the equation

$$\nabla^2\phi = 0 \quad (2)$$

and the boundary conditions

$$\sigma^2\phi + g\frac{\partial\phi}{\partial y} = 0 \quad (3)$$

at $y = 0$ and

$$\frac{\partial\phi}{\partial y} = \frac{\partial\phi}{\partial x}\tan\beta \quad (4)$$

at $y = x \tan\beta$, provided that

$$\sigma^2 = gk \sin\beta \quad (5)$$

where g is the acceleration owing to gravity.

The phase velocity c (from Eq. 5)

$$c = \frac{gT \sin\beta}{2\pi} \quad (6)$$

and the group velocity U (following Lamb, 7)

$$U = \frac{d(kc)}{dk} = \frac{C}{2} \quad (7)$$

have the same relationship as they do for gravity waves in deep water. The period T is given by

$$T = \frac{2\pi c}{g \sin\beta} \quad (8)$$

As is well known (see, for instance, Lamb, 7, p. 413), the principal waves generated in a dispersive system by a moving disturbance are those for which the phase velocity equals the velocity of the disturbance. We may therefore calculate the period of the waves generated by considering c in the period equation as representing the velocity of the disturbance. This was applied in the theory of air-coupled flexural waves by Press and Ewing (*8*) and by Munk, Snodgrass, and Carrier (*3*).

The motion of a particle of water can be determined from the components of velocity parallel to the coordinate axes, $v_x = \partial\phi/\partial x$, and so on, and those perpendicular (v_p) and parallel (v_s) to the bottom. Thus

$$v_p = v_x \sin\beta - v_y \cos\beta = 0 \quad (9)$$

$$v_s = v_x \cos\beta + v_y \sin\beta = -kA \cos(kz - \sigma t) e^{-kD} \quad (10)$$

and

$$v_z = -kA \sin(kz - \sigma t) e^{-kD} \quad (11)$$

where $D = x \cos B + y \sin B$, the distance from the edge to a line through x, y perpendicular to the bottom. Thus, any water particle moves in a circular orbit parallel to the bottom with a radius that decreases exponentially with distance from the shore.

Storm-Surge Data

Pressure data. Isochrones for the 6 July pressure-jump line are shown in Fig. 1. These are interpolated positions based on the exact times and magnitudes of the recorded jumps given in Table 1.

The data indicate that the pressure-jump line moved southward at about 50 miles per hour and crossed the southern

Dr. Donn is a research associate of Columbia University and assistant professor of meteorology and geology at Brooklyn College. Dr. Ewing is professor of geophysics and director of the Lamont Geological Observatory of Columbia University.

Table 1. Pressure-jump data for 6 July 1954.

Station	Time (CST)	Magnitude (in.)
FAR (Fargo)	6:50 A.M.	0.06
STC (St. Cloud)	8:39 A.M.	0.09
MSP (Minneapolis)	9:54 A.M.	0.07
GRB (Green Bay)	11:00 A.M.	0.04
TVC (Traverse City)	12:30 P.M.	0.02
MSN (Madison)	1:02 P.M.	0.08
MKE (Milwaukee)	1:24 P.M.	0.06
MKG (Muskegon)	2:00 P.M.	0.04
CHI (Chicago)	3:30 P.M.	0.10
BTL (Battle Creek)	3:30 P.M.	0.04
SBN (South Bend)	3:55 P.M.	0.06

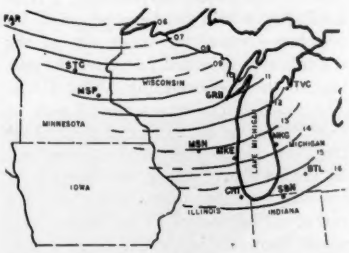

Fig. 1. Isochrones for Lake Michigan pressure-pump line of 6 July 1954.

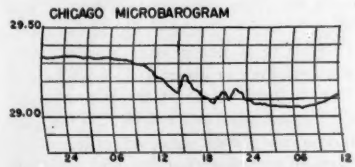

Fig. 2. University of Chicago microbarogram showing pressure-jumps of 6 July 1954. (In this figure and also in Figs. 3, 5, 6, 7, and 9, time is designated in the 24-hour system.)

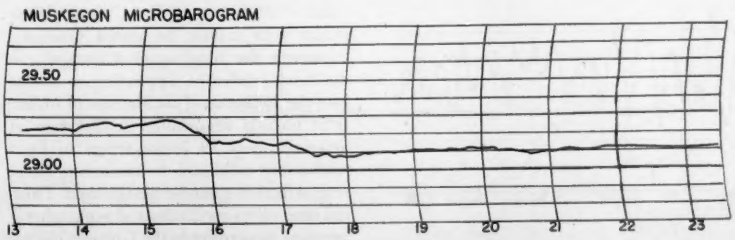

Fig. 3. Muskegon microbarogram of 6 July 1954.

end of the lake just prior to 4 P.M. Furthermore, most of the microbarograms examined show that the pressure-jump was oscillatory, with the primary jump being followed by at least two oscillations of lesser magnitude. A copy of the University of Chicago microbarogram showing these oscillations is reproduced in Fig. 2, which shows that they continued until 12 midnight on 6 July. A copy of the microbarogram from Muskegon recorded on an open time scale is shown in Fig. 3. This location, on the east side of Lake Michigan and much farther north than Chicago, shows a fairly quiet record from 4 P.M. to the end of the day. The significance of this record is discussed following presentation of the wave data.

Wind data. A study of the available anemograms shows that a considerable increase in wind speed occurred with the passage of the pressure-jump. The Wilson Avenue (Chicago) anemogram, for example, shows an increase of from 20 to 70 miles per hour between 3 and 3:30 P.M. A wind shift from south to north accompanied the speed increase. Smaller oscillations in speed and direction occurred with the subsequent pressure oscillations that are described in the preceding paragraph.

Wave data. The stations from which water-level records were studied in detail are shown in Fig. 4, which also shows depth contours (in feet) for Lake Michigan. The contours are based on U.S. Lake Survey chart No. 7, "Lake Michigan." To obtain the wave periods, which are given in subsequent paragraphs, the periods of several wave trains along the record were read and averaged.

Figure 5, which is a copy of the Waukegan wave record, shows some activity above background between 2 and 3 P.M., with the principal wave disturbance beginning at 3 P.M. and continuing with decreasing amplitude until 10 P.M. on 7 July. The wave period recorded is about 110 to 120 minutes. The waves of higher frequency, which are superimposed on these long waves, have a period of close to 20 minutes.

The Wilson Avenue (Chicago) record (Fig. 6) shows a preliminary peak at 3 P.M. and a major wave that began at

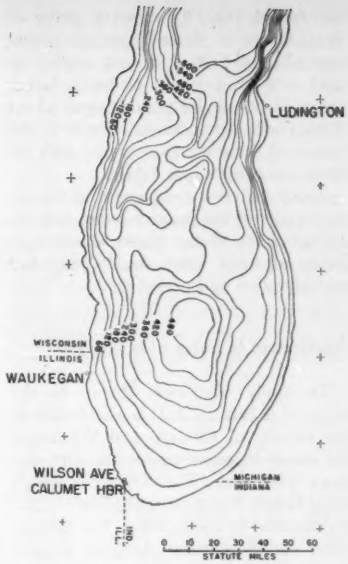

Fig. 4. Bottom topography of Lake Michigan.

3:30 P.M. and reached a crest just after 4 P.M. Again, this initial surge is followed by a prolonged train of higher than normal waves until the close of 7 July. The period is about 97 to 100 minutes, which is close to that for the background waves preceding the surge. Waves of shorter period (18 to 20 minutes) are also present as on the Waukegan records.

Preceding and following the surge at all the southern stations in the vicinity of Chicago and Waukegan, the background waves show a nearly steady state of low-amplitude, long-period oscillations. The period varies from about 2 to nearly 3 hours. Shorter oscillations of 15 to 20 minutes are superimposed on these, just as they are on the higher waves that comprised the surge.

The Calumet Harbor (Chicago) record (Fig. 7) also shows some preliminary activity at 3 P.M., prior to the major surge that began about 3:30 P.M. and reached a maximum at 4 P.M. Above-normal oscillations of the water, which continued through most of 7 July with decreasing amplitude, have a period of about 115 minutes, with waves of shorter period (20 minutes) superimposed. Figure 8 shows the water level at Chicago recorded on a scale convenient to illustrate both the surge and the background oscillations preceding and following it, although the scale does not permit detailed study.

The total duration of the wave disturbance is estimated to have been 29 hours, although the background oscillations continued somewhat higher than normal for a longer time. The reason for the latter is discussed later. The Luding-

ton record (Fig. 9) shows a group of small waves of about 50-minute period beginning at 1:30 P.M. and continuing until 4 P.M. A group of much larger waves of 84-minute period began about 8 P.M., with a maximum crest at 10:30 P.M., and these waves persisted with attenuating heights into 8 July.

Table 2 gives a comparison of the arrival times of the pressure-jump and the arrival times of the major water-wave group at each wave station, together with duration and period data.

Table 2. Summary of pressure and wave data.

Station	Pressure-jump arrival time (P.M.)	Time of first surge wave (P.M.)	Period (min)		Duration of wave disturbance (hr)
			Long-period waves	Short-period waves	
Waukegan	about 3	3	110–120	20	29
Wilson Ave.	3:30	3:30	97–100	18–20	29
Calumet Harbor	3:30	3:30	115	20	*
Ludington	about 1	8–10	84		*

* Record incomplete.

Application to Surge of 6 July 1954

To apply edge-wave theory to the surge of 6 July 1954, it is noted that in the vicinity of Chicago and Waukegan the depth increases uniformly with distance from shore. The distance at which wave height becomes negligible ($\lambda/2\pi$) is estimated to be 16 miles. The bottom slope was determined along six profiles out to the 300-foot contour, from just north of Chicago to 50 miles north of Waukegan. These values of sin β, from north to south, of 0.0029, 0.0034, 0.0035, 0.0024, 0.0021, 0.0016, when inserted in the period equation together with 72.5 feet per second as the value of the phase velocity c, give a mean edge-wave period of 103 minutes for the Chicago-Waukegan area. The mean period of the observed waves, from Table 2, is 109 minutes, giving very good agreement between theoretical and observed values. Although the waves of shorter period (20 minutes) appear explainable numerically, at least on the basis of several different approaches, such as a second mode effect or generation over the steeper northern lake shore, we refrain from discussing them until more data have been compiled from other cases.

By using the velocity equation, we obtain a theoretical edge-wave velocity of 61 miles per hour for the southern half of the lake and 50 miles per hour for the northern half. Because the observed pressure-jump velocity is 50 miles per hour, and because the pressure-jump line is, in reality, a band of some width, it is expected that a considerable resonant transfer of energy would occur from the disturbance in the air to the resulting disturbance in the water. This accounts for the relatively great heights of the water waves that began with the arrival of the pressure jump in the air.

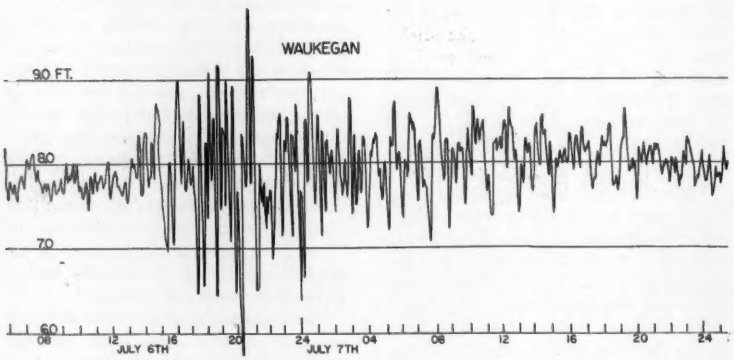

Fig. 5. Waukegan water-level record showing disturbance of 6–7 July 1954.

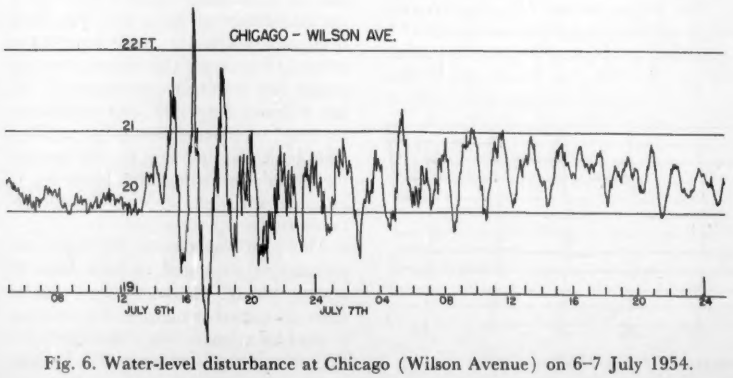

Fig. 6. Water-level disturbance at Chicago (Wilson Avenue) on 6–7 July 1954.

It seems evident from Fig. 4 that the bottom topography northwestward from Ludington would not be appropriate for coupling—hence, the small size of the water waves recorded just after the passage of the pressure-jump, about 1 P.M. The much larger waves after 8 P.M. at Ludington can be explained as arriving from the south. The pressure-jump and associated high waves resulting from resonant coupling reached the southern end of the lake about 4 P.M. These waves would then either be reflected or simply continue to run northward around the eastern edge of the lake. However, they would travel the 165 miles from the southern end of the lake to Ludington, with the group velocity (one-half of the phase velocity c) and would arrive there from 5 to 6 hours after reaching the southern end, or about 9:30 P.M. This is just about the time of the beginning of the major water-wave arrival. Thus, we have a case of high water waves generated through resonant coupling and reaching the station long after the passage of the generating disturbance as the result of reflection. This is similar to the explanation of the disastrous surge at Chicago about 10 days earlier (*1*).

The total duration of the observed water disturbance in the Chicago-Waukegan area cannot be stated precisely. Although the surge started abruptly, it declined gradually, appearing to merge into the background oscillations of higher than normal amplitude. A duration of approximately 29 hours seems to be a reasonable estimate. A minimum theoretical duration can be determined. Thus, the interval of oscillations of atmospheric pressure, according to the Chicago microbarogram (Fig. 2) and others, not shown,

was about 9 hours. Also, it is estimated that the pressure-jump entered the lake about 260 miles north of Chicago. Although the front of the disturbance traveled with the phase velocity, or about the velocity of the pressure-jump, the rear portion of the water disturbance would travel with the group velocity, at about 25 miles per hour and would arrive 5.2 hours after the front of the disturbance. Furthermore, edge waves undoubtedly were generated along the sloping lower half of the eastern margin of the lake. The rear of this disturbance would travel westward around the southern margin of the lake at the group velocity and would increase by about 4 hours the duration of the direct disturbance that traveled down the western edge of the lake. The total theoretical duration is thus estimated to be about 18 hours.

The theoretical edge-wave duration is thus significantly less than the duration of the observed disturbance. But recall that the background water-level oscillations have a period of from 2 to 3 hours, which is close to that of the edge waves. Applying the well-known seiche formula,

$$T = \frac{2l}{\sqrt{gh}}$$

where T is the period, l is the width of the lake (taken here along a profile east of Waukegan), and $\sqrt{h}$ is the mean of the square roots of the depths along the same profile, the theoretical seiche period for the southern portion of the lake is 160 minutes. This agrees well with the observed period of the oscillations having amplitudes above background. It seems reasonable to expect resonance to occur from the addition of energy by edge waves whose period is so close to that of the lake seiche. This would account for the prolonged duration of slowly damped water oscillations having amplitudes above background. An earlier and more general discussion of Lake

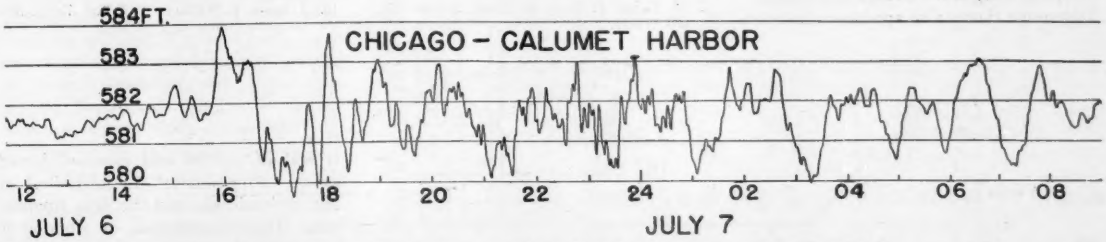

Fig. 7. Water-level disturbance at Chicago's Calumet Harbor on 6–7 July 1954.

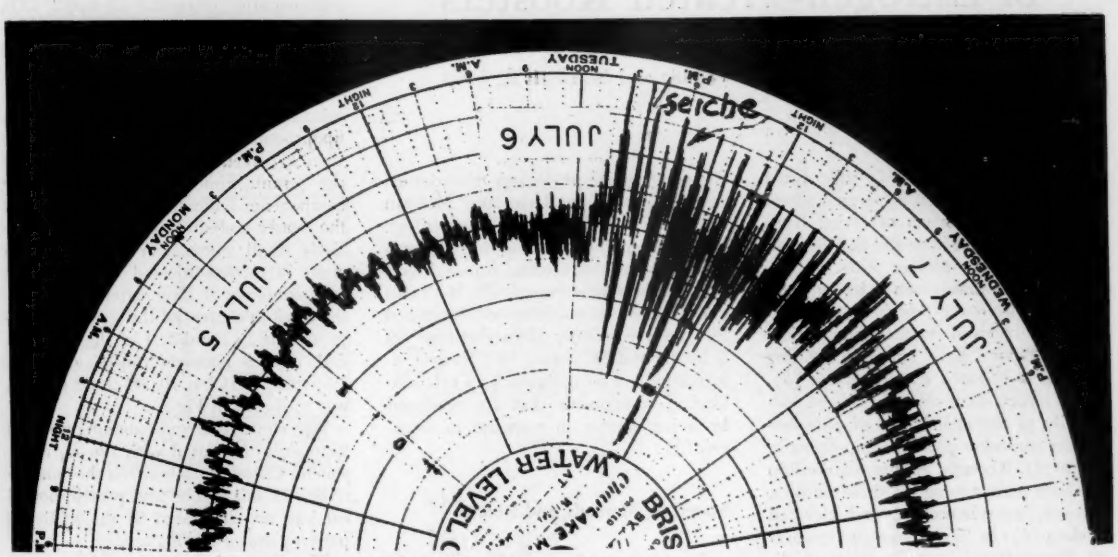

Fig. 8. Chicago (Montrose Harbor) water-level record for 4–7 July 1954.

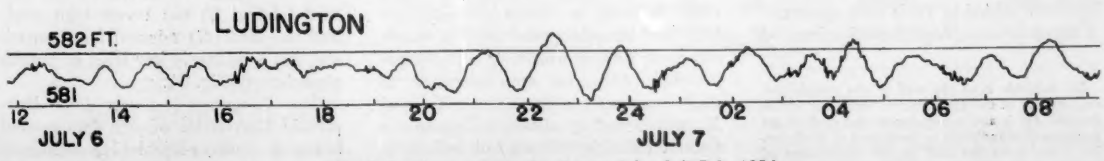

Fig. 9. Ludington water-level record for 6–7 July 1954.

Michigan surges and seiches has been given by Harris (*9*).

Conclusions

The theory of edge waves appears to explain most of the recorded effects of the storm surge of 6–7 July 1954. It seems reasonable to expect that relatively strong and fast-moving atmospheric disturbances, with large components parallel to the lake, have excited such edge waves in the past and will do so in the future. In cooperation with the U.S. Lake Survey, a program of instrumentation is under way to check this theory further and to provide empirical data for a more complete study of the Great Lakes surges. Edge-wave theory also appears to be applicable to the total reflection of deep-water waves near the beach as described by Isaacs *et al.* (*10*).

This study shows again that potentially dangerous waves may be expected at a shore station long after the passage of the generating disturbance in the air. It should be noted that the disastrous surge of 26 June 1954, which was described earlier (*1*) and was explained as originating from resonant coupling to gravity waves, does not permit explanation by the present mechanism, owing to the configuration of the lake bottom at the southern end of the lake and to the transverse path of the disturbance across the lake.

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Proteins and Calcium in Serums of Estrogen-Treated Roosters

Ole A. Schjeide and Marshall R. Urist

In 1935 Laskowski (*1*) discovered phosphoprotein, which he termed *serum vitellin*, in the plasma of laying hens. Riddle (*2*) in 1942 correlated the appearance of this protein with the elevated calcium that is seen in laying birds. Since that time, the protein-calcium system has received further elucidation. Several reports have appeared relating estrogen to elevated serum calcium (*3*). Other reports have related estrogen specifically to the appearance of phosphoprotein and other protein components in serum (*4*). Recently an interrelationship has been seen among all three entities, estrogen, phosphoprotein, and elevated calcium (*5*). In 1956, Clegg and coworkers demonstrated that injection of diethylstilbesterol into cockerels resulted in the introduction to the serum of phosphoprotein that complexed relatively large amounts of ionized calcium-45 that had been added to an *in vitro* system.

In connection with investigations on the comparative physiology of endosteal bone formation by Urist and McLean (*6*), studies utilizing the ultracentrifuge have been made of calcium-binding proteins in serums of roosters injected with massive doses of estrogen (*7*). With this material and the partition cell developed for the preparatory ultracentrifuge by Schjeide and Dickinson (*8*), further information has been obtained on calcium-binding components that are produced by avian species in response to estrogen (*9*).

Dr. Schjeide is on the staff of the Atomic Energy Project of the University of California at Los Angeles. He is also a member of the staff of the department of radiology in the School of Medicine. Dr. Urist is on the staff of the department of surgery in the School of Medicine.

Materials, Methods, and Results

A microsuspension of 125 milligrams of USP estrone (Ayerst) was injected intramuscularly into roosters. Beginning within 24 hours and rising nearly to a maximum within 5 days, there was a large increase in serum chylomicrons (*10*) and beta lipoproteins (*10*), nearly complete disappearance of alpha lipoproteins (*10*), and appearance of at least two new components (X_1 and X_2, as resolved by ultracentrifugation in sodium chloride (88 mg/ml, *p*H 6.0). In Fig. 1 are depicted schlieren patterns typical of control and estrone-injected roosters after removal (by floatation) of the chylomicrons and the beta lipoproteins. The concentration of albumin is practically the same in injected and control birds, despite a tenfold increase in phosphorus.

The X_1 and X_2 components display sedimentation rates of S 7.5 and S 15.0, respectively, when extrapolated to infinite dilution and corrected to 20°C (Fig. 2).

Analyses for calcium (*11*) in chylomicrons, beta lipoproteins, and alpha lipoproteins reveal that these bind less than 5 percent of the total calcium in the serum. Similar analyses on other components indicate that albumin and the denser globulins also bind comparatively small amounts of the serum calcium in estrone-injected birds. Within approximately 3 days after treatment, the calcium content of the serum in compartments 1, 2 and 3, 4 of the partition cell, after 9 hours of centrifugation in 10-percent NaCl at 70,000 times gravity, was as shown in Fig 3.

The elevated serum calcium seems to be mainly associated with the X_1 component. Correlations between the concentration of this species and protein-bound calcium are illustrated by the schlieren patterns shown in Fig. 4.

The X_1 species appears to be a phosphoprotein as shown by comparative studies of alkaline hydrolysis (after removal of lipids) on centrifugal fractions of serums from two different birds. One bird (*A* and *B*) has a very high level, and one bird (*C*) selected for comparison, has a relatively low level of protein phosphorus (Fig. 5).

The X_2 species is a very dense lipoprotein. Correlation of such data as total nitrogen (micro-Kjeldahl), schlieren patterns (ultracentrifuge), total lipid

(*12*), and constituent lipid (*13*), on whole serum minus chylomicrons, beta lipoproteins, and alpha lipoproteins, indicates the approximate composition (*14*) shown in Table 1.

The X_1 protein probably binds little lipid, for a strong correlation was observed between X_2 and the total lipid in fractions containing only albumin, X_1, and X_2.

It was found that component X_1 plus variable amounts of X_2 could be coprecipitated in uncontaminated form simply by dilution with distilled water. Most of the protein-bound calcium was released in the process. The precipitate could be resolubilized by addition of approximately 1-percent NaCl or a lesser amount of $CaCl_2$. When X_1 was separated by ultracentrifugation from X_2, it was soluble in distilled water. However, X_1, when combined with X_2 (water-soluble livetin) in distilled water, resulted in a precipitate composed of aggregates of the two types of molecules.

Previous investigators suggested that colloidal calcium phosphate may account for a large percentage of the non-ionized calcium in estrogenized serum (*15*). We account for nearly all the calcium in the serum as complexed with X_1, albumin, and lipoprotein, and this leaves relatively little for any such form as colloidal calcium phosphate.

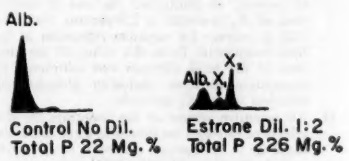

Fig. 1. Schlieren patterns of control rooster (left) and estrone-injected rooster (right). The areas of the peaks are proportional to concentration.

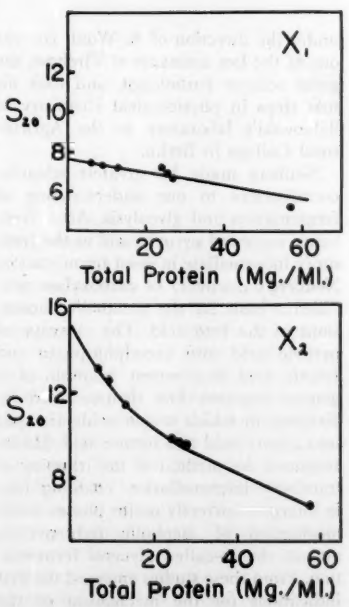

Fig. 2. Sedimentation rates of X_1 and X_2 components.

Discussion and Conclusion

Although the relationship of the components X_1 and X_2 to the elevation of calcium in the plasma is of special interest, other valuable concepts have evolved from these findings. Some of these bear on the relationship between egg yolk vitellin and the $X_1 + X_2$ system of serum.

Vitellin (water-insoluble yolk protein) has been described in the older literature as a single substance. However, recent studies on frog and hen yolk vitellin (*16*) show that it is not a discrete molecule but actually consists of a system of at least two centrifugal and electrophoretic components. One of these is a phosphoprotein, and the other is a relatively dense lipoprotein. In the case of hen vitellin, the sedimentation rates of the components are very similar to

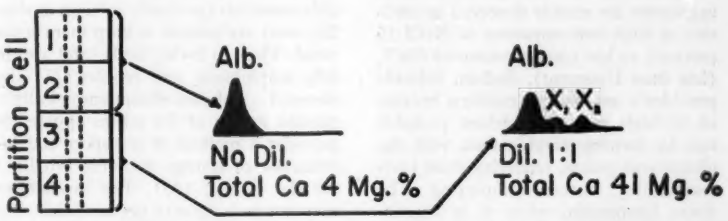

Fig. 3. Calcium content of serum present in the compartments of the partition cell. Chylomicrons and beta lipoproteins were removed by prior floatation. Note that globulins are present in very low concentration and can thus not be responsible for the elevated calcium.

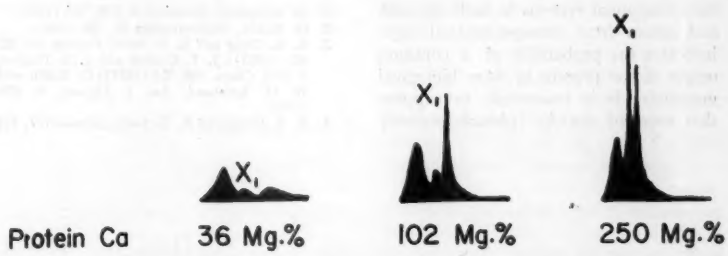

Fig. 4. Schlieren patterns in three different roosters from 3 to 5 days after treatment, showing the correlation between concentration of X_1 and protein-bound calcium. These materials are from compartments 3 and 4 of the partition cell after 9 to 16 hours of centrifugation at 70,000 times gravity. The protein identified with the X_1 peak in the case of the sample on the far right amounts to approximately 2100 milligram percent as concentrated in the fraction. Total serum calcium is approximately 130 milligram percent (*11*).

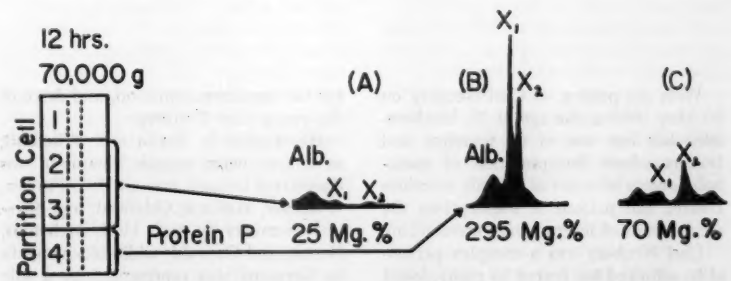

Fig. 5. Schlieren patterns showing the correlation between concentration of component X_1 and protein-bound phosphorus. The protein identified with X_1 peak in the case of sample *B* amounts to approximately 2600 milligram percent as concentrated in the fraction. Protein-bound calcium amounts to approximately 260 milligram percent.

Table 1. Approximate composition of component X_2. Each value was averaged from the results of three experiments.

Component	Amount (%)	Range
Protein	76.5	75.4–78.1
Lipid	23.5	21.9–24.6
Sterol ester	6.8*	6.4– 7.0
Triglyceride	18.8*	18.0–20.0
Sterol	6.2*	5.4– 7.0
Phospholipid	68.2*	66.0–69.6

* Percentage of the lipid component.

those of components X_1 and X_2 of the serum. In the egg yolk, these molecules are linked together as aggregates. Such aggregates are readily dissolved by addition of high concentrations of NaCl (5 percent) or low concentrations of $CaCl_2$ (less than 1 percent). Sodium chloride provides a solubilizing medium because of its high polarity; calcium probably acts by forming combinations with the phosphorus groups, rendering them inaccessible for further complexing. The dense lipoprotein, when it is encountered alone, seems to be identical with the water-soluble material in egg yolk which is commonly referred to as "livetin."

The demonstration of very similar two-component systems in both egg yolk and serum from estrogen-treated birds indicates the probability of a common origin of the protein in these biological materials. It is reasonable to suppose that most of the X_1 (phosphoprotein) and X_2 (lipoprotein) molecules in the serum are destined to be deposited in the egg yolk (phosphoprotein and lipoprotein usually occur in the same relative proportions in both systems). But this occurs as the protein is modified both in physical and in chemical form. The differences between the X_1 component of serum and the phosphoprotein of egg yolk appear to be that the X_1 component of serum is a soluble and discrete substance heavily complexed with calcium; the phosphoprotein of egg yolk is largely insoluble (in platelet or granule form) because it is complexed with X_2 lipoprotein (livetin). It is emphasized that components X_1 and X_2 are soluble in plasma only as long as sufficient dializable materials (probably calcium or similar ions) are present to keep them separated. Thus, in laying birds (and also in fish, amphibians, and reptiles, *17*) the elevated calcium-phosphoprotein-lipoprotein system of the serum apparently provides a method of transport and localization of storage nutrients (vitellin) for the embryo (*15*). The mechanism may not be unique to egg materials, but it may be fundamentally similar to other processes involving the deposition of insoluble structures in cells.

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10. For convenience, lipoproteins floating in a solution of density 1.003 are herein termed *chylomicrons*; complexes floating on solutions of density 1.063 are referred to as *beta* lipoproteins; and those floating on solutions of density 1.21 are labeled *alpha* lipoproteins.
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C. Neuberg, Biochemist

With the passing of Carl Neuberg on 30 May 1956 at the age of 78, biochemistry has lost one of its founders and leaders whose interpretation of metabolic events in terms of organic reactions created the pattern of inquiry into the mechanisms of intermediary metabolism.

Carl Neuberg was a complex personality, admired but feared by many, loved and understood by few. The strict social framework of imperial Germany, with its class consciousness and its military code of honor, provided a strange arena for the ingenuity, ambition, and drive of the young Carl Neuberg.

He studied in Berlin and Würzburg at a time when organic chemistry was dominated by such men as Emil Fischer, v. Baeyer, Wallach, Grignard; and physical chemistry by van't Hoff, Arrhenius, Nernst, and Ostwald; while biochemistry in Germany was represented by a sole chair occupied by Roehmann at the University of Breslau. Neuberg received his Ph.D. degree in 1900 with a thesis on the chemistry of glyceraldehyde carried out under the direction of A. Wohl. He was one of the last assistants of Virchow, the great cellular pathologist, and took his first steps in physiological chemistry in Salkowski's laboratory at the Agricultural College in Berlin.

Neuberg made his greatest scientific contributions to our understanding of fermentation and glycolysis. After Neubauer suggested pyruvic acid as the transitory intermediate in yeast fermentation, Neuberg's discovery of carboxylase provided a basis for the metabolic conversions of the keto acid. The cleavage of pyruvic acid into acetylphosphate and formic acid is a recent example of a general reaction first demonstrated by Neuberg in which α-keto acids are split into a fatty acid and formic acid. He introduced the method of the trapping of transitory intermediaries, enabling him to interpret correctly major phases in the mechanism of alcoholic fermentation and of the so-called glycerol fermentation. From these studies emerged the first indications for the mechanism of the cleavage of Harden-Young's hexosediphosphate into two subunits later iden-

tified as triose phosphates. Neuberg's four forms of fermentation provided the first attempt at an integrated picture of glucose breakdown in which the dynamics of fermentation was explained by the competition of hydrogen acceptors. The observation that substances extraneous to fermentation may act as hydrogen acceptors and that, thereby, a vast number of aliphatic, aromatic, and heterocyclic aldehydes may be reduced to the corresponding aldehydes led to the formulation of the concept of phytochemical reduction. The significance of enzymes giving rise to carbon-carbon linkages such as the transketolase was foreshadowed in the studies on acetoin fermentation and by the discovery of the enzyme carboligase.

Neuberg's studies of the enzymic formation of lactic acid resulted in the introduction of its salts as brake fluids in German artillery pieces during World War I. During the last 30 years Neuberg's interest was attracted to the mechanisms of solubilization of insoluble matter in nature. He explored the effects of organic phosphates and polyphosphates arising in carbohydrate metabolism in the solubilization of insoluble salts, observations which up to now have not made their full impact felt on biological thought.

This short outline of some of Neuberg's main contributions to biochemistry cannot but give a very meager impression of his over-all influence in the field. It does not give an account of his discovery of a host of enzymes, of his studies of the structure of natural products and of his synthesis of phosphorylated intermediates of carbohydrate metabolism. His work was particularly characterized by a multitude of methodological and chemical observations, and many of the chemical tools of our laboratory were discovered and developed by Neuberg and his pupils. He usually contributed not only the concepts but also the techniques to his own work.

The enormous amount of work accomplished by Neuberg and his numerous pupils has been set down in about 900 publications from his laboratory. The Kaiser Wilhelm Institute of Biochemistry in Berlin-Dahlem under his leadership gave opportunity and inspiration to generations of biochemists from Europe, Asia, the Western Hemisphere, and Australia. His influence stemmed not only from his original contributions but also from his editorship of the *Biochemische Zeitschrift*, which he founded at the age of 28, and also from his membership in a number of the highest scientific councils of Germany. After he came to the United States in 1940 he continued to work, often under adverse conditions, and the uninterrupted flow of publications up to the last month of his life attested to a productivity and energy unaffected by age and change of environment.

Neuberg's unquenchable craving for knowledge reached beyond the frontiers of his own science. He was amazingly well versed in classical literature and history, and he read Greek and Latin as well as Hebrew. The sleeplessness of his last years of failing health was, in some measure, appreciated by him because it gave him more time to read.

Two weeks before his death he gave, before a distinguished group of biochemists, a farewell lecture on some of the fundamental enzymic reactions of fermentation as demonstrable by simple experiments. He was too weak to stand, his voice had to be amplified, his daughter read part of the lecture, and an assistant carried out the experiments. But Neuberg's love of biochemistry and his unimpaired power of intellect dominated the audience.

F. LIPMANN
Massachusetts General Hospital, Boston, Massachusetts

F. F. NORD
Fordham University, New York, N. Y.

H. WAELSCH
New York State Psychiatric Institute, New York, N. Y.

News of Science

Statement on Hungary

A declaration that urges the Soviet and Hungarian governments to permit exchanges of visits between Hungarian scholars and those of other countries and to put an end to restrictions on intellectual freedom in Hungary was presented to the Soviet Ambassador and the Hungarian Envoy Extraordinary in London on 4 Dec. The statement was sponsored by the International Committee on Science and Freedom, Didsbury, Manchester, England, and signed by some 1000 scholars from 108 universities and colleges in 23 countries.

Among those presenting the declaration were Prof. Cyril Darlington of Oxford University (a member of the Committee on Science and Freedom and leader of the delegation); Sir David Lindsay Keir, master of Balliol College, Oxford; Prof. Pulleyblank of Downing College, Cambridge, representing the 16 fellows of the college who had given their corporate support to the statement; H. J. Fleure, emeritus professor of London University; and Dame Kathleen Lonsdale, professor of chemistry at University College, London.

Other British supporters of the declaration in Britain are Sir Thomas Murray Taylor, principal and vice-chancellor of Aberdeen University and the senate of the university subscribing as a body; Sir Hector Hetherington, principal and vice-chancellor of the University of Glasgow; Prof. W. Mansfield Cooper, vice-chancellor of Manchester University; Dr. J. W. Cook, vice-chancellor of Exeter University; and Dr. E. M. W. Tillyard, master of Jesus College, Cambridge.

Universities in other countries represented on the list of signers include the Sorbonne, Harvard, Princeton Institute of Advanced Studies, Columbia (New York), Rome, Padua, Berlin, Göttingen, Tokyo, Canberra (Australia), Athens, Vienna, Leiden (Holland), Hamburg, Ottawa, Buenos Aires, and Istanbul. The American Association of University Professors sent in a supporting declaration.

The document presented to the Soviet Ambassador read:

"We have heard the repeated calls for help from Hungarian intellectuals, scholars, scientists and writers, addressed to their colleagues throughout the world.

"We express to you our deep concern at the fate of our colleagues in Hungary and appeal to you to restore to them the rights of intellectual freedom and free cultural contacts with scholars in other countries.

"We ask you to give your answer in the most practical manner: namely by permitting at once a free exchange of visits between scholars outside Hungary and those in the Hungarian Universities and by ending immediately all restrictions on intellectual freedom."

NSF Employment Profile of Scientists, 1954–55

Comprehensive information on the employment and other characteristics of American scientists is made available in a bulletin released recently by the National Science Foundation. The report, *Employment Profile of Scientists in the National Register of Scientific and Technical Personnel, 1954–55,* is based on the replies of more than 94,000 scientists who supplied information to the Register. It contains the most recent data available on so large a number of scientists, including about 27,000 chemists, 16,300 biologists, 12,200 psychologists, 11,800 geologists (including 3400 geophysicists), 11,200 physicists, 6700 chemical engineers, 5400 mathematicians, 3200 meteorologists, and 400 astronomers.

More than 41 percent of the employed scientists in the Register held the Ph.D. degree; 25 percent attained a master's degree; and 32 percent had the bachelor's or first professional degree (M.D., and so forth). Fewer than 2 percent of scientists reported no degree.

Scientists at the doctorate level in 1954–55 reported a median annual salary of $7000, those with less than a Ph.D. degree—$6125. Highest median salary was for Ph.D. physicists and meteorologists—$7850. Lowest salaries were for psychologists—$5850. Salaries are not only dependent on educational attainment, but also on such things as age, sex, type of employer, and functions to which scientists devote the major part of their time. The data on salaries is less representative than the information on other employment characteristics, however, because the chemists and chemical engineers did not report salary information.

About one-half of the employed scientists held a job in industry (private companies, self-employed, nonprofit foundations, and privately controlled research foundations). Almost one-third were employed by educational institutions; and the remaining 18 percent by the Government (federal, state, and local).

Research, development, or field exploration was the primary function of half the scientists; management or administration, of 18 percent; and teaching, of 16 percent. In this, as in other respects, basic differences among the various scientific fields appear. Teaching, for example, was reported as the major function of almost 40 percent of the mathematicians, but of only 4 percent of the chemical engineers.

About 7000 women scientists were included in the Register total of 94,000, and 85 percent of these were in three fields—psychology, chemistry, and biology. The psychologists made up the largest group of women scientists. One out of every four psychologists was a woman. Next to psychology in terms of the proportion of women scientists was astronomy, one out of every six; in mathematics, one out of every ten.

The National Science Foundation Act of 1950 established the Register, which is administered jointly by the foundation and a number of professional societies. The information in the bulletin is based on voluntary registration with these cooperating societies. Limited numbers of copies of this bulletin are available. Requests should be addressed to: National Science Foundation, Washington 25, D.C.

USIA University Catalog Program

The U.S. Information Agency has undertaken a program to distribute overseas catalogs of American institutions having graduate schools. The purpose of the project is to acquaint people in other countries with the facilities of American higher education. USIA will bear all costs of transporting the material. To function effectively, the program will require 200 catalogs from each cooperating college or university.

Institutions wishing to participate in this project should write to Mrs. Anna B. Hendricksen, Information Center Service, U.S. Information Agency, 1776 Pennsylvania Ave., Washington 25, D.C.

Cancer Mortality Decline

Metropolitan Life Insurance Company statisticians have reported a downward trend over the past 10 years in the cancer death rate among women in middle life. Among the company's millions of industrial policyholders, mortality from all types of cancer was down by 13 percent for women at ages 45 to 64 over the 10-year period. There has been a one-third decline in the death rate from uterine cancer in this age range.

While the cancer death rate for middle-aged women declined, that for men rose somewhat. This was due principally to increased mortality among males from cancer of the lungs, buccal cavity, stomach, and urinary organs.

Army Ionizing Radiation Center

Sharpe General Depot at Stockton, Calif., has been chosen as the site for the U.S. Army Ionizing Radiation Center. The facility will be built by the Army Corps of Engineers and will include a nuclear reactor that is to be constructed by the Atomic Energy Commission.

The center will investigate the use of ionizing radiation in the preservation of food and conduct other projects of interest to the Department of Defense. The Quartermaster Research and Development Command at Natick, Mass., will direct its operation.

The AEC reactor and related equipment will cost an estimated $3 million. A preliminary design for the reactor, which will be of the water-moderated type with solid fuel elements, is now being completed for the commission by Internuclear Company of Clayton, Mo. The AEC is considering 11 proposals made by industrial concerns for the engineering design, fabrication, and construction of the reactor.

Other facilities of the center, costing an estimated $4,500,000, will include a high-energy particle accelerator to be procured by the Quartermaster Corps, and offices, laboratories, and processing and storage areas that will be constructed by the Corps of Engineers according to specifications being developed by the Quartermaster Corps.

Initially the center will have as its primary mission the development of methods of utilizing ionizing radiation to preserve foods and to determine the economic feasibility of such a process. This aspect of the center's activities will be performed in conjunction with the Quartermaster Food and Container Institute, Chicago, which is conducting the overall Quartermaster Corps research and development program in the field of radiation preservation of food. This program includes contracts with 16 universities as well as contracts with research institutes and industrial concerns located throughout the country. The center is expected to be in operation in 1958.

NBS Boulder Radio Propagation Engineering Division Reorganized

The Radio Propagation Engineering Division of the National Bureau of Standards Boulder Laboratories has been reorganized with the original two research sections divided into seven new units. The reorganization is designed to facilitate the increased research that has grown out of the recent development and widespread use of tropospheric scatter propagation, radio noise, modulation, and navigation techniques. Two new assistant division chiefs have been named and eight other scientists given new assignments in the reorganization. Kenneth Norton continues as chief of the division.

J. W. Herbstreit and Kenneth O. Hornberg are the new assistant division chiefs. Herbstreit, who formerly was in charge of all tropospheric work, will now supervise research and development. Hornberg, the project leader of the Cheyenne Mountain tropospheric radio propa-

gation experiments, will be responsible for technical administration of the division's engineering and logistical work.

Moody C. Thompson has been appointed as a consultant to do original research on microwave refractometers and special instruments relating to tropospheric effects on radio waves propagation. James R. Wait, a theoretical physicist, will continue to serve in his capacity as a consultant.

The new sections and section chiefs are as follows: data reduction instrumentation, Walter E. Johnson; modulation systems, Arthur D. Watt; navigation systems, Gifford Wefley; radio noise, William Q. Crichlow; tropospheric measurements, Charles F. Peterson; radio systems application engineering, Robert S. Kirby; and tropospheric analysis, Philip L. Rice.

FWS Study of Fish Chemistry

The Fish and Wildlife Service of the Department of the Interior has inaugurated a continuous study of the protein, fat, mineral, and vitamin content of all species of fish used for food. There are about 160 species of fish and shellfish used on American tables and the nutritive elements vary with the subspecies, the season and area of capture, sex, and various other conditions. While such technological studies have been made from time to time on a few species, the knowledge of the changing nutritive values of even the most-studied varieties is insufficient to meet modern demands, and for most of the 160 species such knowledge is either entirely lacking or fragmentary.

Instructions have been sent to each of the fishery laboratories operated by the Service—Seattle, Boston, Ketchikan (Alaska), College Park, (Md.), and Pascagoula (Miss.)—to conduct the necessary chemical analysis on a continuing basis on samples of the fish in their respective areas. These samples will come from commercial catches and from fish taken by the exploratory fishing vessels operated by the Service. Laboratory tests will also be made on any new or unusual fish caught by the exploratory ships.

In the light of present chemistry, fish are divided into two classes, fatty and nonfatty. Fish having more than 3 percent fat are listed in the fatty category. Cod, flounder, haddock, halibut, yellow perch, and yellow pike are among those considered as nonfatty, but the degree will vary from time to time. Salmon, mackerel, ocean perch, and sable fish are among the fatty species, with mackerel varying from three to 22 percent and salmon and the others showing variations almost as wide. Pacific rockfish vary up and down from the 3 percent line; scallops are nonfatty; oysters are nonfatty but high in the carbohydrate-type (glycogen) energy source as well as the valuable protein component.

News Briefs

■ The Indian Government plans to set up a Central Astronomical Observatory that is to be under the Indian Meteorological Department. The new facility will have a 74-inch telescope, one of the largest in the world.

■ The National Tuberculosis Association has reported the following TB statistics: more than 15,000 people die annually of the disease, despite the decline in death rate; 11 states and the District of Columbia had an increase in death rate in 1955 as compared with 1954; nearly 80,000 new active cases are being reported annually; in people over 65 years of age, one death is reported for every two cases; infection is taking place, in some parts of the country, at the rate of one person per 100 population a year.

■ The earth satellite that is being constructed by the Navy's Project Vanguard for launching during the International Geophysical Year will receive a coat of pure gold instead of the shiny, silvery one originally ordered. Brooks and Perkins, Inc., of Detroit, Mich., manufacturer of the sphere, said a change in specifications calls for gold plating 1/30,000 of an inch thick.

■ A very low incidence of dental caries among children in the village of Bang Chan in Thailand has been noted by researchers for the Southeast Asia Program of Cornell University's department of Far Eastern studies. Hazel Hauck of the New York State College of Home Economics of Cornell, who has been associated with the Bang Chan project since its start in 1950, reports that among the 226 children surveyed, 68 percent had no cavities in their permanent teeth.

Scientists in the News

WILLIAM J. MORGAN, formerly research director for unconventional warfare in the Office of the Chief of Psychological Warfare in the Department of the Army, has been appointed to the position of chief of the Motivation and Development Branch in the Civilian Personnel Office in the Office of the Chief of Staff, Department of the Army.

L. EUGENE ROOT of the Lockheed Aircraft Corporation has been appointed a vice president of the corporation and general manager of its expanding new Missile Systems Division. A former executive in the Rand Corporation and chairman of the Aerodynamics Advisory Panel for the Atomic Energy Commission at Los Alamos, Root will succeed HALL L. HIBBARD, a senior vice president who has been serving as pro tem director of the division.

Starting in Van Nuys, Calif., the division has built a staff of 5000 scientists, engineers, technicians, and craftsmen and this fall began occupancy of a new plant in the San Francisco Bay area. This plant includes some 200,000 square feet of research laboratories at Stanford University's Industrial Park and 350,000 square feet of engineering, manufacturing, and administrative space in nearby Sunnyvale.

MITSURU NAKAMURA, formerly research associate in microbiology at Boston University School of Medicine and associate professor of microbiology at the New England College of Pharmacy, has been appointed associate professor of bacteriology and chairman of the department at Montana State University, Missoula. His research activities have dealt with the nutrition, biochemistry, chemotherapy, and immunology of *Endamoeba histolytica*.

PAUL FUGASSI, director of the Coal Research Laboratory at Carnegie Institute of Technology; George Ostapchenko, a graduate student of chemistry at the institute; and Ruth Trammell, instructor in chemistry at Chatham College, have received the American Chemical Society's bituminous coal research award for having delivered the best paper presented before the gas and fuel chemistry division's session at the ACS annual meetings last September.

THURMAN B. GIVAN and BENJAMIN KRAMER, both pediatricians, have been appointed clinical professors emeritus by the State University of New York College of Medicine in Brooklyn. Givan has been a member of the faculty of the college and its predecessor, the Long Island College of Medicine, since 1919. He served as president of the Kings County Medical Society in 1946 and has been New York State chairman of the American Academy of Pediatrics, president of the Brooklyn Academy of Pediatrics, and president of the Brooklyn Pediatric Society.

Kramer joined the college in 1926. He was associate attending pediatrician at Johns Hopkins University and pediatrician-in-chief at Brooklyn Jewish Hospital before assuming his post at the college. Kramer, who is president of the pediatric section of the New York Academy of Medicine, is known for his work in calcium metabolism.

TURNER G. TIMBERLAKE has been appointed chief of the mechanical engineering department at the Corps of Engineers' Research and Development Laboratories, Fort Belvoir, Va. He fills a position left vacant when Robert W. BEAL was promoted to the position of director of applications engineering. Previously Timberlake, who has been with the Corps of Engineers for 10 years, had been chief of the maintenance engineering division of the Engineer Maintenance Center in Columbus, Ohio.

W. L. FAITH, chief engineer of the Air Pollution Foundation (Los Angeles, Calif.) since the organization began operations in 1954, has been named managing director of the organization. He succeeds LAUREN B. HITCHCOCK, who has resigned to return to private consulting practice in the industrial research and development field.

LLOYD E. THOMAS, formerly a professor in the biochemistry department of the University of Missouri School of Medicine, has joined the laboratory staff of the Good Samaritan Hospital, Portland, Ore., to start a research program at the hospital.

OTTO WALCHNER, aeronautical research engineer at the Air Research and Development Command's Wright Air Development Center, Ohio, has received the decoration for exceptional civilian service, the highest civilian award that the Air Force bestows, for his work as a research physicist in the field of armament aerodynamics. The citation, signed by the Secretary of the Air Force, read in part, "His outstanding and timely research in the critical problem of bomb release and predictability of its trajectories has resulted in developments of extraordinary importance." Besides the citation, the award consists of a gold medal and gold lapel emblem.

A former German scientist, Walchner was born in Weil, Germany. During World War II he worked as a research professor with the German Air Force at the Aerodynamics Research Center, Goettingen, Germany. He came to the United States in 1946 and was employed by the Air Force through the Joint Intelligence Objectives Agency alien specialist program.

PHINEAS J. SPARER, chief of psychiatry and psychosomatics at the Memphis (Tenn.) Veterans Hospital, has joined the staff of the University of Tennessee College of Medicine as professor of psychiatry and of preventive medicine. Sparer, author of the recent book *Personality, Stress and Tuberculosis,* has had extensive training in both the medical and psychological disciplines.

ALEXANDER SYMEONIDIS, former head of the geographic pathology unit of the National Cancer Institute, has been appointed professor of pathology and director of the Cancer Institute, Aristotelian University School of Medicine, Thessaloniki, Greece.

The American Society of Civil Engineers has awarded its 1956 research prizes as follows: to FRED BURGGRAF, Washington, D.C., associate director of the Highway Research Board, "in recognition of outstanding contributions to knowledge through the administration of research in highway engineering and construction materials"; to CHESTER P. SIESS of the University of Illinois, Urbana, "in recognition of outstanding contributions to knowledge through his research on reinforced concrete slabs"; and to VINTON W. BACON, Sacramento, Calif., executive officer of the California State Water Pollution Control Board, "in recognition of achievements in applied research on waste water reclamation, pollution and water quality."

LAWRENCE M. KUSHNER has been selected to head the newly organized metal physics section of the National Bureau of Standards Metallurgy Division. He is the former assistant chief of the surface chemistry section. The new section will supplement the present program of the division's other four sections in the broad fields of mechanical, chemical, and thermal metallurgy and corrosion.

The Institute of Radio Engineers, Inc., has announced the recipients of three of its annual awards for 1957. The presentation of these awards will be made during the IRE national convention, which will be held 18–21 Mar. in New York.

O. G. VILLARD, JR., professor at Stanford University, Stanford, Calif., will receive the Morris Liebmann memorial prize "for his contributions in the field of meteor astronomy and ionosphere physics which led to the solution of outstanding problems in radio propagation."

DONALD RICHMAN, supervising engineer at the Hazeltine Corporation, Little Neck, N.Y., will receive the Vladimir K. Zworykin prize "for contributions to the theory of synchronization, particularly that of color subcarrier reference oscillator synchronization in color television."

GEORG GOUBAU, physicist at the Signal Corps Engineering Laboratories, Fort Monmouth, N.J., will receive the Harry Diamond memorial prize "for his many contributions in ionospheric research and circuit theory and for his discovery of the surface wave transmission principle."

J. REID CLEMENT, JR., a physicist at the Naval Research Laboratory, Washington, D.C., has been awarded the Meritorious Civilian Service award for his achievements in cryogenics. The award is the second highest given to a civilian employee. Clement was recognized for his development of a carbon-composition thermometer and for his research and recommendations which lead to international agreement on a new temperature scale. As a result, Clement's thermometer is presently being used in most low temperature laboratories in this country as well as in Europe and Asia.

SIDNEY N. GELLIS, who recently concluded 5 years as chief of the tuberculosis section in the Veterans Administration Hospital at Tucson, Ariz., has joined the research staff of Eli Lilly and Company, Indianapolis, Ind.

ROLLAND PERRY has rejoined Argonne National Laboratory as an associate physicist in the Particle Accelerator Division. From 1946 to 1948, and from July 1951 through September 1951, Perry was with Argonne as an associate physicist; since that time, he has been head of the department of physics at Utah State College.

Recent Deaths

THOMAS S. ARBUTHNOT, Pittsburgh, Pa.; 85; president of the Carnegie Hero Fund and former dean of the medical school at the University of Pittsburgh; 2 Dec.

RAYMOND E. BASSETT, Durham, N.H.; 52; chairman of the department of sociology at the University of New Hampshire; 4 Dec.

HARRY R. BRYSON, Manhattan, Kan.; 64; associate professor of entomology at Kansas State College; 3 Dec.

HORACE G. BYERS, Arlington, Va.; 83; head of the chemistry department at Cooper Union from 1919–28; chief of the division of soil chemistry and physics of the Bureau of Chemistry and Soils, U.S. Department of Agriculture until 1942; 2 Dec.

LESTER D. GARDNER, New York, N.Y.; 80; founder of the Institute of the Aeronautical Sciences; 23 Nov.

S. PHILIP GOODHART, New York, N.Y.; 84; former professor of neuropsychiatry at New York Polyclinic Medical School and professor of clinical neurology at the College of Physicians and Surgeons of Columbia University; 6 Dec.

NATHAN C. GROVER, Washington, D.C.; 88; retired chief hydraulic engineer for the U.S. Geological Survey; 29 Nov.

LANDON C. HAYNES, Greenville, Tenn.; 99; professor emeritus of physics

and mathematics at Tusculum College; 1 Dec.

ALICE M. HUNT, Westport, Mass.; 76; associate professor emeritus of anesthesia at the Yale University School of Medicine; 30 Nov.

GEORGE T. MOORE, St. Louis, Mo.; 87; emeritus director of the Missouri Botanical Garden; 27 Nov.

HENRY F. PERKINS, Burlington, Vt.; 79; professor emeritus of zoology at the University of Vermont; 24 Nov.

WALTER A. SCHNEIDER, Hastings-on-the-Hudson, N.Y.; 57; professor of physics at New York University; 20 Nov.

ALICE M. SCOTT, Philadelphia, Pa.; 79; one of the first women to receive a Ph.D. in chemistry from the University of Pennsylvania; 30 Nov.

MELVILLE B. WELLS, Chicago, Ill.; 70; professor emeritus and former head of the aeronautical engineering department at Armour Institute of Technology; 1 Dec.

WILLIAM P. WOODSIDE, Phoenix, Ariz.; 79; founder member of the American Society for Metals; 5 Dec.

Education

■ The University of Rochester will add an electrical engineering course to its curriculum next fall. Students entering the program will have the option of taking a 4-year course leading to a degree of bachelor of science in electrical engineering, or a 5-year course in which both the bachelor of science and the bachelor of arts degree will be given simultaneously.

■ The Medical Division of the Oak Ridge Institute of Nuclear Studies has announced that it will present a series of six thyroid-uptake seminars this winter and next spring to provide instruction in a standard method of calibrating the uptake of radioiodine by the thyroid. Two of the sessions will be open to invited physicians and physicists; two will be open to all other qualified physicians and physicists; one will be designed for manufacturers' representatives; and one will be open to qualified technicians.

These seminars are an outgrowth of a thyroid-uptake calibration program initiated by ORINS more than 3 years ago. In the first phase of the program, life-size half-body mannequins containing simulated thyroid glands with suitable amounts of "mock-iodine" (a radioactive barium-cesium mixture whose gamma emission spectrum closely resembles that of iodine-131) were sent about the United States and England for testing by approximately 300 scientists and physicians. The results of these tests were correlated by the Medical Division to determine the efficacy of the various testing methods used, and the information obtained was applied to studies made at a seminar for experts in the thyroid-uptake field held at ORINS in September.

In view of the success of the September seminar, the six seminars have been scheduled. Detailed information and application forms may be obtained by writing to Mr. William Busby, ORINS Medical Division, P.O. Box 117, Oak Ridge, Tenn.

■ A new cancer chemotherapy laboratory, which also serves as headquarters for the pharmacology department of the Stanford University Medical School, has been established on the university's Palo Alto campus. The pharmacology move marks the first step toward consolidation of the medical school facilities, now in San Francisco, with the university proper. By 1959 the entire school is expected to be housed in a $22-million medical center soon to be started on the campus.

Avram Goldstein, who heads the pharmacology department, will direct the new research facility, which was built and equipped with the aid of $50,000 from the National Cancer Institute of the U.S. Public Health Service, plus $10,000 from university funds. A radioisotope laboratory also has been set up in the new space with gifts totaling $6700 from the Ladies Auxiliary of the California Department of the Veterans of Foreign Wars.

The cancer chemotherapy laboratory is located in the basement of the Anatomy Building. It has three offices, seven laboratories, an animal room, and several small special-purpose rooms. An additional grant of $68,000 from the National Cancer Institute is supporting research for the first year.

■ The 87th annual report of the American Museum of Natural History that has just been released includes a historical survey of the museum's educational services. The publication points out that the museum's first direct teaching program —a zoology course for teachers given in 1880 by one instructor—was to lead to the establishment of the Department of Public Instruction, which today has perhaps the largest teaching staff of any museum in the world.

In the year covered by the report 1,783,433 people visited the museum and 573,000 visited its planetarium—a total attendance of 2,356,433. In addition, nearly 18 million people were reached through courses, lectures, and circulating exhibits, films, and slides.

■ The second astronomical observatory in New York City—the only other is Columbia University's—will be opened for use in January at the Fieldston School, an independent school attended by some 600 students that is one of the three New York Ethical Culture schools. Fieldston is one of the first secondary schools in the country to have its own observatory.

Both the observatory and its 8-inch Newtonian-type telescope are the work of an amateur astronomer, Eugene Kada, whose profession is precision instrument making. In 1950 Kada gave his 8-inch telescope to the school, and he has spent all his spare time for the past 3 years in planning and building an observatory in which to mount the 7-foot, 200-pound instrument. The new facility, the Kada Observatory, is a hexagonal structure that has been erected on the roof of Fieldston's auditorium, which stands on the highest hill in the area. It is 13 feet to the top of the observatory's revolving dome.

■ The first radioactive cobalt-60 unit for cancer therapy in the state of Maryland has been installed in the University of Maryland's division of radio therapy of the department of radiology in Baltimore. Assembly work on the $28,500 machine has just been concluded with the insertion of the $6500 cobalt source. Approximately $18,000 has been spent in renovation of part of the university's Psychiatric Institute to provide treatment, waiting, and dressing rooms; offices; and an especially equipped room for the 3-ton machine.

To be known as the Martha V. Filbert Radiation Center, the facility was made possible by a $35,000 gift from the Filbert Foundation as a memorial to Mrs. Filbert by her son, Alvin B. Filbert; her daughter, Mrs. E. H. Landauer; and her late son, John H. Filbert. Other gifts to the cancer therapy center included $8000 from the University Hospital's Women's Auxiliary Board and $5000 from the National Brewing Company of Baltimore.

Grants, Fellowships, and Awards

■ The American Academy of Arts and Sciences recently reviewed 34 applications for grants from its Permanent Science Fund Committee. Thirteen grants, totaling $6693.20, were awarded. They covered projects in biology, chemistry, botany, and mathematics.

The academy invites applications for grants from its Permanent Science Fund. Awards are made in support of research in any field of science whatsoever in amounts that ordinarily do not exceed $1500. Applications for grants to be made in the early spring should be filed *by 1 Feb. 1957* on forms that may be obtained from: The Chairman, Permanent Science Fund Committee, American Academy of Arts and Sciences, 77

Massachusetts Ave., Cambridge 39, Mass.

Special consideration will be given to projects on new frontiers of science; those that lie between, or include, two or more of the classical fields; and those proposed by investigators who may be on the threshold of investigational careers or who are handicapped by inadequate resources and facilities. The committee does not ordinarily approve grants for research the results of which constitute partial fulfillment of requirements for an academic degree.

■ Under a program supported financially by the Carnegie Corporation of New York, arctic research scholarships are offered to students possessing a bachelor's or master's degree or equivalent. Usually these funds are for students who wish to proceed to a doctoral degree in a subject calling for active field research in Arctic or Subarctic North America; however, candidates who do not intend to proceed to a degree are not necessarily disqualified.

The scholarships are tenable at McGill University, Montreal, Canada. Such subjects as anthropology, bacteriology, botany, geography (including glaciology and meteorology), geology, genetics, parasitology, psychiatry, psychology, sociology, and zoology (including marine biology) will be considered, and successful candidates will be enrolled in one of these departments.

The scholarships ordinarily provide $1500 for the academic session, and $1250 for the expenses of a summer's field expedition. If renewed for a second session, the scholarships have an average value of $1750.

Applications should be submitted to the Secretary of the Carnegie Arctic Program, McGill University, 539 Pine Avenue West, Montreal, P.Q., Canada, and should include a confidential recommendation of the candidate's qualifications in his or her selected field, and a clear statement of the intended arctic or subarctic research project. No particular form is required when applying for these scholarships. However, a request should be sent at the same time to the Dean, Faculty of Graduate Studies and Research, McGill University, for forms used for application for admission to the Graduate Faculty. Applications for 1957–58 should reach Montreal *by 15 Mar. 1957*.

■ Each year the American Therapeutic Society presents the Oscar B. Hunter memorial award in honor of its late secretary, Dr. Oscar B. Hunter. Nominations are invited for the award, which is made in recognition of an outsanding contribution or series of contributions to therapy by an individual or a team of workers. The term *therapy* is used in a broad sense to include the use of any drugs, procedure, or device of benefit in the treatment of patients.

One object in making the award is to bring recognition to those who have not been honored for their work. The award consists of a bronze medal struck in the likeness of Dr. Hunter and engraved with the name of the recipient. The winner will be expected to present a paper on his award work at the time of the presentation of the medal. Travel expenses to the presentation meeting will be furnished.

The deadline for receiving nominations is *1 Feb. 1957*. For details, write to Dr. Harry E. Ungerleider, 393 Seventh Ave., New York 1, N. Y.

In the Laboratories

■ Arthur D. Little, Inc., has announced plans for expansion in Cambridge and Concord, Mass. Purchase of 170 acres in Concord and immediate new construction at the plant in Acorn Park in Cambridge are included in these plans.

■ The Franklin Institute has announced the creation of a Nuclear Engineering Division in the institute's Laboratories for Research and Development. Francis L. Jackson is associate director of the laboratories in charge of the new division. Under his leadership nearly 30 specialists in the fields of heat transfer, fluid mechanics, stress analysis, physics, chemistry, electronics, and so forth, are engaged in nuclear engineering programs. Establishing this activity as a major division is a step designed to increase the laboratories' ability to render service to the Government and to the rapidly expanding industries in the Delaware Valley.

■ The Shell Development Company, New York, has announced plans for a $1-million expansion program for its Modesto agricultural research center, near Salida, Calif. Shell will bring more than 50 families into the Modesto area from Denver, Colo., and other Shell laboratory locations. A total staff of more than 100 people will be employed.

■ Midwestern Instruments, Inc., Tulsa, Okla., and Magnecord, Inc., Chicago, Ill., have announced the approval of terms for a merger of the two organizations. The merger plans are being submitted to the stockholders of both companies for immediate action.

Midwestern Instruments, with annual sales at the rate of $4.5 million, is a leading manufacturer of oscillographs, galvanometers, torque motors, and other industrial electronic equipment. Magnecord, noted largely for its professional and industrial magnetic tape recording equipment, reports annual sales in excess of $2.5 million. Present plans are for operation of Magnecord as a division of Midwestern Instruments, with an integration of personnel of both organizations.

New Journals

Acta Palaeontologica Polonica, vol. 1, No. 1. Roman Kozlowski, Ed. Geological Committee, Polish Academy of Science, 72 Nowy Swiat, Palac Staszica, Warsaw. Quarterly.

Bibliography of Medical Reviews, 1955. Armed Forces Medical Library, Washington 25.

C.S.I.R.O. Wildlife Research, vol. 1, No. 1, September 1956. Commonwealth Scientific and Industrial Research Organization, 314 Albert St., East Melbourne, C.2, Victoria. Irregular. 10s per issue.

Data, vol. 1, No. 4, November 1956. Murray Smith, Ed. Finley Enterprises, 4202 12th Place, NE, Washington 17. 24 issues per year, $12.

The International Journal of Applied Radiation and Isotopes, vol. 1, Nos. 1 and 2. Pergamon Press, 122 E. 55 St., New York 22. Issued in parts. $17 per vol.

Journal of Neurochemistry, vol. 1, No. 1. Pergamon Press, 122 E. 55 St., New York 22. Issued in parts. $14 per vol.

Journal of Technology, vol. 1, No. 1, June 1956. S. K. Chakrabarty, Ed. Bengal Engineering College, P.O. Botanic Garden, Howrah, India. Semiannual. $2.50.

Military Electronics, vol. 1, No. 1, October 1956. Sheldon E. Fitterer, Ed. Electronic Periodicals, Shaker Square, Cleveland, Ohio. Monthly.

The New Scientist, No. 2, 29 Nov. 1956. The New Scientist, Cromwell House, Fulwood Place, High Holborn, London, W.C.1. Weekly. $8.50 per year.

The Physics and Chemistry of Solids, vol. 1, Nos. 1/2, September/October 1956. Harvey Brooks, Ed. Pergamon Press, 122 E. 55 St., New York 22. Issued in parts. $17 per vol.

Physics in Medicine and Biology, vol. 1, No. 1, July 1956. J. E. Roberts, Ed. Taylor and Francis Ltd., Red Lion Court, Fleet Street, London, E.C.4. £1 per part; £5 10s per year.

Publicaciones Didacticas del Instituto de Matematica y Estadistica, vol. 1, No. 1. Facultad de Ingenieria y Agrimensura, Montevideo, Uruguay.

Science Reports of the Society for the Research of Theoretical Chemistry, vol. 1, No. 1, December 1955. M. Odagiri, Ed. Society for the Research of Theoretical Chemistry, Kinki University, Osaka, Japan.

Reports

Influence of Adult Tissue Homogenates on Formation of Similar Embryonic Proteins

In 1916 Murphy (*1*) discovered that chorioallantoic grafts of adult chicken spleens cause an enlargement of the spleens of host chick embryos. After an eclipse of some 20 years, these and related phenomena have become the subject of renewed interest, largely as a result of the investigations and commentary of P. Weiss (*2*). An investigation of this effect by means of tracer methods has recently been initiated by Ebert (*3*), who has shown that, as a result of the graft of labeled adult tissues, the specific radioactivity of the corresponding host organ is considerably higher than that of other embryonic tissues. We have extended these investigations to the use of injected tissue homogenates. While this paper was in preparation, there appeared a report by Tumanishvili *et al.* (*4*) that heart and liver extracts, when they are injected into chick embryos lead to specific enlargements of host organs.

In the experiments reported here (*5*), chicken-liver and heart homogenates were prepared and radioactively labeled in their proteins with S^{35}-sulfur amino acids. *Torulopsis utilis* was grown on S^{35}-sulfate (obtained from Oak Ridge National Laboratory), according to the method of Wood and Perkinson (*6*). After extraction with organic solvents (*7*), the yeast proteins were hydrolyzed with a 1/1 mixture of 6*N* HCl and 90-percent formic acid. The humin was removed by centrifugation, and a portion of the neutralized hydrolyzate corresponding to 50 mc of the original S^{35}-sulfate was injected intraperitoneally into a White Leghorn hen in two doses about 5 hours apart. Eight hours after the second injection, the blood was withdrawn by heart puncture, and the tissues were frozen.

Several months later the tissues were thawed and homogenized in a tris(hydroxymethyl)aminomethane buffer solution at *p*H 7.4 containing 0.9 percent KCl, first in a Waring Blendor and then in a Potter-Elvehjem homogenizer. The liver and heart homogenates, made up to 10 percent (weight/volume) with the same buffer solution, were then treated with cysteine at a *p*H of 8.0 to 8.5 to assure removal of all exchangeable S^{35}. After dialysis, some undissolved material was removed by low-speed centrifugation, and the relatively clear supernatant was used for intravenous injection into 9-day-old White Rock chick embryos, as described in a subsequent paragraph. Aliquots of the homogenates were mixed with carrier serum and precipitated with trichloroacetic acid; dry protein powders were prepared and counted as described by Walter *et al.* (*8*). All counts were corrected for self-absorption and decay.

Embryonated White Rock eggs were incubated at 38°C under controlled humidity conditions for a period of 9 days. They were candled on the ninth day to locate the blood vessels, and the location of the latter was marked on the shell of each egg. An area of about 1 cm^2 of the shell above the vessel was carefully cut out by means of a dental drill and burr without injuring the membrane, and the small square was removed with a razor blade. A drop of mineral oil was placed on the membrane to render it transparent, and 0.1 ml of the liver or heart homogenate was intravenously injected in the direction of blood flow. The eggs were reincubated for 24 hours and the embryos excised. Hearts and livers were removed, pooled, and homogenized; dry protein powders were prepared for counting according to the method cited in a previous paragraph.

The results of these experiments are given in Table 1. In all, two series of experiments make up the table. In the first series, 24 embryos each were injected with heart and liver homogenates; of these, 22 and 11, respectively, survived. In the second series, 44 out of 47 embryos injected with the heart preparation survived, while the number of survivors was 22 out of 28 for the liver homogenate. Thus the table summarizes data obtained on 99 survivors out of 123 embryos that were injected: 66/71 for heart; 33/52 for liver.

It can be seen that the relative specific activity of hearts is higher than that of livers when chicken heart homogenate is injected, whereas the relative specific activity of the livers is higher than that of hearts when chicken-liver homogenate is injected. It has therefore been demonstrated that injected homogenates give results qualitatively and quantitatively similar to those obtained on grafting chicken tissues to the chorioallantois (*3*). A tentative interpretation of these findings is that there occurs a preferential localization of the injected material in the tissue of origin, perhaps due to the transfer of specific protein moieties. Preliminary surveys indicate that the relative proportions of sulfur-containing amino acids in the two tissues under investigation cannot account for the results observed.

We are extending these investigations to the use of subcellular tissue fractions and to heterologous (rabbit) hearts and livers in an effort to delineate the nature of the mechanism responsible for these results.

Table 1. Results of 24-hour incubation of 9-day-old chick embryos after injection with tissue homogenates.

Item	Injection							
	Chicken heart homogenate				Chicken liver homogenate			
Count/min per embryo injected	398		398		2780		2780	
Mg injected per egg	0.1		0.1		0.1		0.1	
Organs investigated	Hearts	Livers	Hearts	Livers	Livers	Hearts	Livers	Hearts
No. of organs cut out	22	11	22	11	11	11	11	11
Dry protein wt. of organs obtained (mg)	38.2	72.0	38.8	70.0	84.7	20.9	77.6	22.4
Wt. counted (mg)	18.3	29.8	23.4	30.0	30.1	11.6	30.2	12.6
Count/min observed*	21	24	22	19	366	173	389	214
Corrected count/min per 30 mg	28	24	25	19	365	286	386	340
Relative specific activity	1.00	0.86	1.00	0.76	1.00	0.78	1.00	0.87

* Counts per minute are within 5 percent standard deviation.

HARRY WALTER
DAVID W. ALLMANN
H. R. MAHLER
Department of Chemistry, Indiana University, Bloomington

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13 November 1956

Uronic Acid of Chondroitin Sulfate B

Chondroitin sulfate B has been isolated as the major mucopolysaccharide component of skin, ligamentum nuchae, tendon, and heart valves, and it has also been found in other tissues (*1*). It was differentiated from the chondroitin sulfates A and C by its rotation, its solubility in aqueous ethanol, and its inertness to testicular hyaluronidase (*2*). Desulfated B was differentiated from desulfated A by its resistance to the bacterial hyaluronidases. All the chondroitin sulfates show molar ratios of unity of uronic acid-to-N-acetylgalactosamine-to-sulfate when the uronic acid is determined by the orcinol colorimetric (*3*) or the Tracey CO_2 (*4*) method. However, the carbazole colorimetric value (*5*) of B is markedly lower. The low value is retained in the desulfated product and also in fractions of low molecular weight obtained after acid hydrolysis.

The five available uronic acids or their lactones were investigated, and three yielded low carbazole values (Table 1), indicating that a uronic acid other than glucuronic may be present in B.

Chondroitin sulfate B (carbazole-to-orcinol ratio = 0.41) was hydrolyzed on the steam bath in the presence of Dowex 50 (H^+). The products of hydrolysis were fractionated on a Dowex 1 × 10 (acetate) column with increasing concentrations of acetic acid. The first acidic fraction removed was a mixed disaccharide fraction that was separated preparatively by paper chromatography (butanol, acetic acid, and water; 50:12:25) into disaccharides I and II. Disaccharide I, the major disaccharide product, yielded a carbazole-to-orcinol ratio similar to that obtained from iduronic acid (Table 1), and a hydrolyzed sample produced a spot on a paper chromatogram with an R_f value identical to that of iduronic acid. The disaccharide has recently been obtained in crystalline form and is under investigation. It was similarly shown that disaccharide II contains glucuronic acid as its uronic acid moiety. Both disaccharides contained galactosamine as the only demonstrable hexosamine present under the conditions of the ninhydrin oxidation method (*6*).

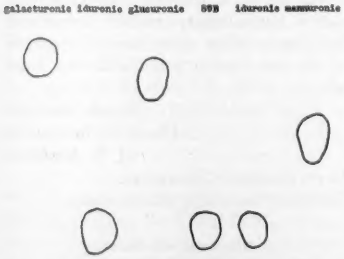

Fig. 1. Trace of a paper chromatogram of the uronic acids and of sample 59B isolated from chondroitin sulfate B. Guluronic acid (not shown) has a mobility similar to that of glucuronic acid in this solvent system (*7*).

Table 1. Colorimetric uronic acid values of the uronic acids or their lactones and fractions isolated from the Dowex-1 column. D-Glucurone was used as a standard.

Compound	Carbazole	Orcinol	Carbazole/orcinol ratio
D-Glucurone	100	100	1.0
L-Gulurone	32	106	.30
L-Iduronic acid	29	130	.22
D-Mannurone	17	128	.13
D-Galacturonic acid	120	127	.95
57B	21	66	.32
59B	41	92	.45
Disaccharide I	12	53	.23
Disaccharide II	33	29	1.2

The next acidic fraction from the Dowex-1 column was a sirup. It was passed through an Amberlite IRC 50 (Na^+) column and freeze dried as the crude sodium salt. Samples 57B and 59B (Table 1) were obtained in two different runs. The reducing values indicated that these were monosaccharides. Paper chromatography (Fig. 1) revealed a spot with an R_f value equal to that of crystalline L-iduronic acid. A trace spot with an R_f value equal to that of glucuronic acid was also present, and this accounts for the difference in carbazole-to-orcinol ratios of the isolated acid and synthetic iduronic acid.

Aqueous solutions of the free uronic acids or their lactones, with the exception of galacturonic acid, which does not form a lactone, each showed two spots on paper chromatograms due to acid-lactone equilibria. The isolated uronic acid and the synthetic iduronic acid had identical R_f values for both acid and lactone in four different solvent systems. Identical mobilities of the isolated and synthetic acids were also obtained on paper electrophoresis in 0.1*M* borate buffer (*p*H 9.4) and in 0.1*N* acetic acid.

This appears to be the first isolation of iduronic acid from a biological source and of a uronic acid other than glucuronic acid from an acid mucopolysaccharide. However, there is an interesting parallel in the isolation of L-guluronic acid from alginic acid (*8*), for L-guluronic acid is the C-5 epimer of D-mannuronic acid, the same relationship that L-iduronic acid bears to D-glucuronic acid (*9*).

PHILIP HOFFMAN
ALFRED LINKER*
KARL MEYER
Department of Medicine, College of Physicians and Surgeons, Columbia University, New York, and *Edward Daniels Faulkner Arthritis Clinic, Presbyterian Hospital, New York*

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* Established investigator of the American Heart Association.

10 October 1956

Anomalous Carbon-14 Content of Carbon Dioxide from Sewer Gas

During a study of the carbon-14 content of atmospheric carbon dioxide, an attempt was made to use sewer gas as a source of modern carbon. In the course of this work, an anomalous, high content of C^{14} in the CO_2 fraction of this gas has been found.

Sewer gas was piped directly into our laboratory from the adjacent sewage-treatment plant that processes sewage from the District of Columbia. The plant employs primary treatment followed by anaerobic digestion. The gas from the digestion process consists principally of methane (65 to 70 percent) and carbon dioxide (30 to 35 percent) with low percentages of nitrogen, oxygen, carbon monoxide, and other gases. A similar material was used in the first identification of C^{14} in nature (*1*).

Carbon dioxide samples were obtained by passing the sewer gas through a sodium hydroxide solution. The remainder of the CO_2 was removed by suitable absorbers, the CO_2-free methane was converted to CO_2 by passage over hot copper oxide, and the CO_2 was absorbed

Table 1. Radioactivity of acetylene prepared from the methane and carbon dioxide fractions of sewer gas.

Collection date	Methane fraction		Carbon dioxide fraction	
	Count/min minus background	Ratio CH_4/standard	Count/min minus background	Ratio CO_2/standard
3 Jan. 1955			8.67	1.10 ± 0.015
20 Jan. 1956	7.65	0.98 ± 0.016	8.93	1.14 ± 0.016
10 Apr. 1956	7.71	1.00 ± 0.016	8.81	1.14 ± 0.015
1 June 1956	7.58	1.00 ± 0.016	8.76	1.18 ± 0.015
8 June 1956	7.70	1.02 ± 0.016	8.96	1.16 ± 0.014

Table 2. Measured activity of standard samples.

Sample No.	No. of measurements	Count/min minus background	S. D. of measured values (%)
W214	17	7.73	± 1.9
W218	3	7.76	± 2.1
Lignite (background)	22	(4.69)	± 1.4

in another sodium hydroxide solution. The two fractions were further purified, converted to acetylene, again purified, aged to allow radon to decay and assayed for C^{14} using the technique developed by Suess (*2*).

The results of several collections made at different times are shown in Table 1, along with the standard deviation of each sample count.

The radioactive background of the counter was determined from the average of two measurements made before and after the sample count, using acetylene prepared from fossil carbon furnished as strontium carbonate by Meyer Rubin of the U.S. Geological Survey. Rubin also supplied samples of acetylene gas (W218) and strontium carbonate (W214) prepared from modern wood (*3, 4*). Table 2 gives average values of the counting rates obtained with the afore-mentioned standard samples. The measurements were made over the same 6-month period during which all of the sewer gas samples were assayed. In each instance, the appended standard deviation was computed from the measured counting rate. Although the standard deviations are somewhat larger than the errors expected on the basis of total count alone, we feel that they are reliable indices of the over-all accuracy of our measurements. No additional correction for chemical processing appears to be necessary since in an experiment in which three samples were collected and prepared as nearly identically as possible, the final results were well within the counting errors.

The results indicate that the C^{14} content of the methane fraction of sewer gas is in reasonable agreement with that of modern wood. However, the carbon dioxide fraction has a C^{14} content about 14 percent higher than has been found for contemporary biological carbon. Since both the CO_2 and CH_4 are presumably derived from biological decomposition, these results indicate an entirely unexpected enrichment of the carbon dioxide fraction of sewer gas.

R. L. Patterson, Jr.
I. H. Blifford, Jr.
U.S. Naval Research Laboratory, Washington, D.C.

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4. We wish to thank M. Rubin for supplying the three standard samples.

12 October 1956

Modified End-Window Counting Tube for Paper Chromatograms

The counting of radioactive compounds directly on paper chromatograms after autoradiography has come into increasing use by various laboratories since the development of the technique (*1*) and its extensive use for photosynthetic studies by Calvin and his group (*2*). The most successful way of counting was by the use of the mica end-window "Scott tube" (*3*). A number of disadvantages of the tube have been resolved in the design (Fig. 1) described in this report (*4*).

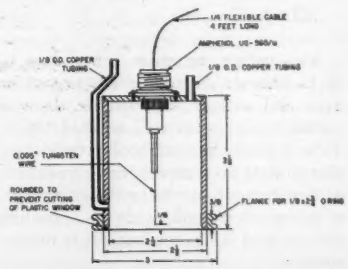

Fig. 1. Brass counting tube machined from ¼-in. brass stock tubing.

The counting tube was easily machined from stock brass tubing. The end window is constructed from DuPont Mylar of 0.25-mil thickness which is stretched tightly across the end and clamped into position with a rubber "O" ring (*5*). The brass tube and flange are rounded during machining to prevent cutting the plastic. Mylar has the advantage that it is extremely durable and cheap. If contaminated, it can be washed with ethanol or water or quickly replaced with a new window. The Mylar is porous, and air can diffuse into the tube, so a slow flow of quenching gas is kept running through the counting tube via the copper inlet.

The male plug of an Amphenol connector is machined into the top of the tube. A tungsten wire is connected to the anode, and the brass casing of the tube acts as the cathode. The male plug is then attached to the female plug of the connector with a 3- or 4-ft flexible cable to a scaler. With this convenient connector, several tubes can be kept in readiness and easily attached to the cable or scaler. It is important that the cable be freely flexible so as to allow freedom of motion and stability of the counting tube on the chromatograms.

The choice of a quenching gas with this tube is apparently not too important. With "P-10" gas (90 percent argon and 10 percent methane) counting can be done in 2400 v. The tubes show a good plateau (3-percent rise for 250 v) between 2250 and 2500 v. If "Q" gas is used, a good plateau is obtained at around 1200 to 1500 v, depending on the individual tube. The tubes are of course unshielded and give a background count of 60 to 70 counts per minute. With both C^{14} and S^{35}, a ratio of distintegrations to observed counts of about 10 is obtained. This tube has also been used successfully to count both P^{32} and tritium. Several of these tubes have been in use for more than a year and have given highly satisfactory and reproducible results (*6*).

R. C. Fuller
Biology Department, Brookhaven National Laboratory, Upton New York

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4. This research was carried out at Brookhaven National Laboratory under the auspices of the U.S. Atomic Energy Commission.
5. The glass Scott tube was also adapted to a Mylar end window recently by Paul Hayes at the University of California Radiation Laboratory.
6. I wish to thank Casimir Nawrocki of the electronics department at Brookhaven for assistance in the design of this counting tube.

15 October 1956

Book Reviews

Microscopium. Communication No. 95. Maria Rooseboom. National Museum for the History of Science, Leiden, 1956. 59 pp. Illus.

The curator, Maria Rooseboom, tells the story of the microscope and the essential discoveries made with it from the early 17th century, partly with words, mainly with superb illustrations. The spirit and style of her book are set with a quotation from the Court Physician Borel, who wrote the first independent publication on microscopy (1656—9 years before the *Micrographia*). A synoptic chart relates by century her choice of the leading events in economy, politics, philosophy and art, physics and chemistry, biology and medicine, and microscopy. The development of the compound microscope is described with respect to its optical parts, illumination, arrangements for focusing, movement of the specimen, stand and foot, and the binocular body. The simple microscopes are considered. Discoveries "with the aid of the optical microscope of importance for medical science" are tabulated from 1660 to 1924, and a section on the microscope and medical science sketches the advances made as men could see cells and tissues better and better. Rooseboom has read this early literature and uses apt quotations to reconstruct actual history.

Many of the 115 illustrations are sketches in which the details of microscope improvements show in minimum space, yet very little of the basic advancement is omitted. Large (10-in.) colored pictures include the Marshall, Culpeper, Martin Drum, Tripod, Martin Grand, and Amici Horizontal microscopes. Other microscopes, parts of them, drawings and photomicrographs are shown in halftone. Some pictures reveal what could be accomplished with the inferior images before achromatism. Selected typical 19th-century microscopes are contrasted in silhouette on a page. The bibliography includes 17 references.

The book reads easily and, despite its compactness, leaves the reader with a clear picture of the changes and improvements in the microscope and in the knowledge gained from its use. Some readers will learn that mechanical stages, low fine adjustments, and other present-day conveniences are only improvements on centuries-old inventions. Very little essential material is left out, although other historians would make other choices, and Rooseboom's interpretations are reasonable. She starts with a written reference of 1621 and makes no attempt to name the first inventor of the compound microscope or to comment on the preferences of others for this honor.

The binocular biobjective and polarizing microscopes are barely mentioned. Zernike's phase-contrast receives two pages, while fluorescence, ultramicroscopy, and other methods are omitted or mentioned only in passing. Achromatism, " . . . salvation . . . just around the corner . . ." is a well-told story in which the name of Tolles is conspicuously absent. I am sorry that no effort was made to show the actual sizes of the microscopes, especially in the colored plates, which show the beauty but not the noble size of early microscopes.

Seminar programmers on the history of science will rejoice in this ready-made, beautifully illustrated answer for the history of the microscope, and we may hope that Olivier of the Netherlands, Pfizer, Inc., will stimulate and sponsor volumes on other instruments in the Leiden Museum for the History of Science, for I am sure the curator would enjoy writing the guide books for us.

OSCAR W. RICHARDS
American Optical Company

Flow of Gases through Porous Media. P. C. Carman. Academic Press, New York; Butterworths, London, 1956. 182 pp. Illus. $6.

This volume serves as a backdrop to P. C. Carman's contributions to surface area and surface flow studies. It is a valuable book with well-selected topics. It is a much needed book, considering that to date no comprehensive treatment of flow through porous media exists. It is a well-written book, with an appealing format, and is not too long. It is recommended.

I have had occasion to compile nearly all available references on the subject of flow through porous packings or beds. Until Carman's initial contribution (1938) calling attention to the Austrian Kozeny's fundamental equation of flow through porous media (1927)—it would be interesting to know how Carman happened on this reference—the important papers on the subject probably numbered less than 20. Since 1938, there have been added no less than 500 separate pieces, and all these begin with the Kozeny-Carman equation. There is no end in sight, though definitely there has arrived the point of diminishing return. More than 95 percent of all contributions have concerned themselves with the so-called "Kozeny-Carman" constant; it is at present doubtful that such a constant in the true sense of the word exists. Actually it is really no more a "Kozeny-Carman" constant that it is a "Darcy" constant, and this most contributors to the subject fail to appreciate. But none of this detracts from the text. It is an author's privilege to conform with current usage and acceptance of terms.

Outstanding is the chapter on flow of sorbable gases. Carman has made a number of important contributions to this subject. The treatment given in the text is simple and direct. He has put together the subject matter with care and the topic is well integrated.

There are some sins of commission and omission as always there must be in a "first" book on a subject. There is, for example, too little said about the subject of permeability—the many discussions regarding its true units. The unit of the "Darcy" is attributed to Muskat (1937), but credit belongs to Fancher, Lewis, and Barnes (1933). The author gives recognition to Schiller (1923) for application of the hydraulic radius concept in deriving the so-called "Kozeny-Carman" equation; this reference antedates that of Kozeny, and it would appear that the "Kozeny-Carman" equation should be called the "Schiller-Carman" equation. But this is actually not the case. It is hard to believe that the author could have overlooked the hydraulic radius approach, which should actually be credited to Fair and Hatch (1933). These investigators derived the Kozeny equation independently of Kozeny. Yet there is no mention of this, although Carman uses precisely the approach Fair and Hatch developed. No discussion of just what Kozeny did is given in the text.

Carman's initial contribution was to apply the Kozeny equation to the measurement of the specific surface area of particles. Although I (1937) was doing the same thing at the same time and quite independently, using Blake's (1922) porosity function, my work is not mentioned but Blake is cited. These mat-

ters are omissions to the proper historical development of the subject, although they do not militate against the usefulness of the text and do not distort the over-all perspective and design of the subject matter treated.

J. M. DallaValle
Georgia Institute of Technology

Air Pollution Handbook. Paul L. Magill, Francis R. Holden, and Charles Ackley, Eds. McGraw-Hill, New York, 1956. 720 pp. Illus. $15.

The growing problem of air pollution in urban environments has resulted in increased demand for information from scientists, air-pollution control officials, engineers, manufacturers, and, in some instances, the lay public. The introduction of a handbook on this subject therefore is very timely, and the present volume fills this need in a comprehensive manner.

This handbook is divided into 14 sections covering major items, such as the importance of city planning and plant location and the physical and chemical aspects of the problem. There are also three chapters covering biological aspects —namely, the epidemiology of air pollution, the effects of air pollutants on farm animals, and the effects of air pollutants on plants. From the evaluation standpoint, sections are provided on sampling procedures and analytic methods and experimental test methods; from the control standpoint, chapters are provided on equipment and processes, legislation, and meteorological aspects.

The book is well organized in spite of the fact that it has a large number of contributors. The contributors are well qualified in their phase of the problem. The material is covered in a direct manner as in technical handbooks, but each chapter is extremely well documented with references. Because of the new information rapidly being developed in this field, it is difficult for any such comprehensive handbook to be completely up to date upon release. Fundamentals and background for each problem are well covered in this book. Information on all types of pollution sources is included and discussed in detail. Of particular interest, from a fundamental standpoint, are the chapters on the physics of the atmosphere and the evaluation of weather effects.

Epidemiology of air pollution which is discussed by Phair is perhaps the only major area in which extended quantitative information is lacking. The chapter indicates this lack to be a serious problem. Essentially, the material presented in this section is a statement of the problem. Quantitative information is limited to localized incidents, such as those at Donora and in London.

The sections on analytic methods, sampling procedures, and the experimental test methods provide enough information for new workers entering the field or those desiring further knowledge in far more detail than the customary handbook. In these areas the book approaches a textbook and should, therefore, be very useful for teaching advanced students in the field of community air pollution.

The section on abatement of air pollution is perhaps more descriptive than applied in terms of design of air and gas cleaning equipment. It provides fundamental knowledge and references, however, which enables those interested to pursue the subject in greater detail. Considerable discussion of combustion problems, as related to incinerator design and operation, is included which will be very useful.

This recent book is highly recommended for those interested in the air-pollution field in general and as a working handbook.

Leslie Silverman
Harvard School of Public Health

Determination of Organic Compounds. K. G. Stone. McGraw-Hill, New York, 1956. 233 pp. Illus. $5.

This book appears to have been designed as a textbook for courses in quantitative analysis of organic compounds. With the growing importance of organic chemical technology, some departments of chemistry have felt that training in such methods should be offered to their students. For such courses K. G. Stone's book should be popular. It is carefully and logically organized and contains much discussion of both the theoretical and practical aspects of organic quantitative analysis.

I was struck by both the breadth of the theoretical discussions and the many references to contemporary literature. Thus, the author, in discussing the use of lithium aluminum hydride in the quantitative determination of active hydrogen in organic compounds, includes a table with references describing the action of the reagent on a large number of organic functional groups as well as that of immediate interest; and, under the methods for the determination of weak acids by titration in nonaqueous media, he seizes the opportunity to introduce the reader to general acid-base theory and the "leveling effect." From these two examples chosen at random, it should be apparent that the text represents far more than a mere catalog of analytic methods with a discussion of sources of error.

Only two procedures of importance were omitted: the use of ultraviolet and infrared absorption spectroscopy in organic quantitative analysis, and the Kuhn-Roth determination of carbon-linked methyl groups, which is very useful in work with natural products.

Richard H. Eastman
Stanford University

Computers. Their operation and applications. Edmund C. Berkeley and Lawrence Wainwright. Reinhold, New York; Chapman & Hall, London, 1956. 366 pp. Illus. $8.

This book is offered as a successor to Berkeley's 1949 book *Giant Brains or Machines That Think*. It is a general description of analog and digital computers and their elementary principles. The section on applications is very general, and almost all of ten pages of comments by prospective users are 5 to 7 years old. Little information is given on the experience of the many companies who have bought or rented computers. The section describing Berkeley's miniature computer, Simon, is longer than that describing recent large-scale computers. No information is given on any of the numerous medium-sized computers now available. Apparently the book's "Checklist of characteristics," pages 65–71, has been reprinted without acknowledgement from the *Electronic Digital Computer Survey* by the Vitro Corporation of America.

William W. Youden
National Bureau of Standards

The Image. Kenneth E. Boulding. University of Michigan Press, Ann Arbor, 1956. 175 pp. $3.75.

This monograph is the by-product of a year spent by the author, an economist, at the Center for Advanced Study in the Behavioral Sciences, Stanford, California. It is an exercise in abstraction, an attempt to indicate the relatedness to varied fields of study of a single conception; and it bears both the virtues and defects of being a memorandum, as Kenneth Boulding himself describes it, dictated without interruption in "a certain atmosphere of intellectual exaltation . . . which no sober editing can quite remove." It proposes, with modesty but certainly no less than half-seriousness, the creation of a new science.

Boulding's central idea is that of "the image," and its study he names *eiconics*. While he draws generously on the biological, as well as behavioral, sciences, his own intellectual habitat would seem to fall most naturally within the soci-

ology of knowledge—or, as he carefully avoids calling it until the last chapter, epistemology. Eiconics is a close neighbor of cybernetics. Where communications theory is not concerned with the semantic content of messages, however, the theory of images is concerned—in terms of the effect of information on its recipient. Those who wish Boulding's thesis in a single sentence will find it on page 7: "The meaning of a message is the change which it produces in the image."

This is, of course, to do great injustice to his book, which is witty and courageous and deserves critical study. The author is himself the first to protest its limitations. As he anticipates, specialists will undoubtedly discover that he has rifled their own storehouses somewhat more to his convenience than theirs; and generalists may well lament that he has belatedly arrived at notions of hierarchy and form which others had reached before him ("unfortunately," he cheerfully admits, "I find it easier to remember messages than their sources"). All of which is more or less necessary camouflage, a protective screen of deference to the means by which his ideas are most likely to be disparaged. Granted that his method of didactic exposition, common to so many memoranda produced for and by seminars, juxtaposes platitudes and profundities in startling contrast, the lapses may profitably be ignored, for where he is profound, he is very close indeed to his admirably extravagant objective.

ERIC LARRABEE

New York, N. Y.

New Books

CERN Symposium on High Energy Accelerators and Pion Physics, Proceedings. vol. 1, *High Energy Accelerators*; 567 pp.; F.40. Vol. 2, *Pion Physics*; 443 pp.; F. 40. European Organization for Nuclear Research, Geneva, 1956.

Education and Human Motivation. H. Harry Giles. Philosophical Library, New York, 1957. 108 pp. $3.

Glaucoma. Transactions of the First Conference, 5–7 December 1955, Princeton, N.J. Frank W. Newell, Ed. Josiah Macy, Jr. Foundation, New York, 1956. 251 pp. $4.50.

Studies in Differential Equations. Series in Mathematical and Physical Sciences, No. 3. Harold T. Davis, Ed. Northwestern University Press, Evanston, Ill., 1956. 114 pp. $1.75.

An Introduction to Cybernetics. W. Ross Ashby. Wiley, New York, 1956. 295 pp. $6.50.

Psychology. General, industrial, social. John M. Fraser, Philosophical Library, New York, 1956. 310 pp. $7.50.

In the Last Analysis. Adam E. Armstrong. Philosophical Library, New York, 1956. 115 pp. $3.

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Dictionary of Anthropology. Charles Winick. Philosophical Library, New York, 1956. 579 pp. $10.

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Administrative Medicine. Transactions of the Fourth Conference, 31 October–2 November 1955, Princeton, N.J. George S. Stevenson, Ed. Josiah Macy, Jr. Foundation, New York, 1956. 251 pp. $4.25.

Miscellaneous Publications

(Inquiries concerning these publications should be addressed, not to Science, *but to the publisher or agency sponsoring the publication.)*

Birds of Midway and Laysan Islands. Museum Pictorial No. 12. Alfred M. Bailey. Denver Museum of Natural History, Denver, Colo., 1956. 130 pp. $2.

A Study of Human Weight Lifting Capabilities for Loading Ammunition into the F-86H Aircraft. WADC Technical Report 56–367. ASTIA Document No. AD 97206. Irvin Emanuel, John W. Chaffee, John Wing. Wright Air Development Center, Wright-Patterson Air Force Base, Ohio, 1956 (order from ASTIA Document Service Center, Knott Building, Dayton 2, Ohio). 12 pp.

Symposium on Vitamin Metabolism. Proceedings of a symposium held under the auspices of the University of Texas and the National Vitamin Foundation, Inc., New York, 6 March 1956. Nutrition Symposium Ser., No. 13. National Vitamin Foundation, New York, 1956. 118 pp. $2.50.

Census Atlas Maps of Latin America. Greater Antilles. Census Atlas Project. U.S. Department of Commerce, Washington 25, 1956 (order from Bureau of the Census, Washington 25). 7 maps. $1.

Laboratory Manual to Accompany Fundamentals of Chemistry and Applications. Charlotte A. Francis, Edna C. Morse, Helen R. Chadwick. Macmillan, New York, ed. 2, 1956. 190 pp.

Statistics of Higher Education: Faculty, Students, and Degrees 1953–54. Chapter 4, Section I, Biennial Survey of Education in the United States, 1952–54. Henry G. Badger and Mabel C. Rice. 142 pp. $0.45. *Federal Funds for Education, 1954–55 and 1955–56.* Bulletin 1956, No. 5. Clayton D. Hutchins, Albert R. Munse, Edna D. Booher. 163 pp. $0.60. U.S. Office of Education, Washington, 1956 (order from Supt. of Documents, GPO, Washington 25).

Report of the Trustees of the Australian Museum for the Year Ended 30 June 1955. Parliament of New South Wales, Sydney, N.S.W., 1956. 7 pp. 9d.

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Noise Evaluation of Air Force Ground Support Units. WADC Technical Note 56–335. John N. Cole. 24 pp. *A Statistical Comparison of the Body Typing Methods of Hooton and Sheldon.* WADC Technical Report 56–366. C. Wesley Dupertuis and Irvin Emanuel. 26 pp. Wright Air Development Center, Wright-Patterson Air Force Base, Ohio, 1956 (order from ASTIA Document Service Center, Knott Building, Dayton 2, Ohio).

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Climatology of Summer Fogs in the San Francisco Bay Area. University of California Publ. in Geography, vol. 10, No. 3. Clyde Perry Patton. University of California Press, Berkeley, 1956. 88 pp. $2.

Seminars in Archeology: 1955. Memoirs of the Society for American Archaeology, No. 11. American Antiquity, vol. XXII, No. 2, pt. 2. Robert Wauchope, Ed. Society for American Archaeology, Salt Lake City, Utah, 1956. 158 pp. $1.50.

Meetings and Societies

High-Polymer Chemistry

The seventh Canadian High Polymer Forum, cosponsored by the Chemical Institute of Canada and the National Research Council of Canada, was held in Sarnia, Ontario, 8–9 Nov. 1956. Papers were presented on all phases of high-polymer chemistry.

Radical reactions continue to hold the interest of a large segment of the group interested in the fundamentals of high-polymer chemistry. R. J. Orr found that when aconitic acid and styrene were copolymerized, the acid molecules in the polymeric chain affected the reactivity of the growing radical. To determine reactivity ratios, it was found necessary to modify the conventional copolymerization equation to take account of charges on the reacting species, the ionic strength of the medium, and the dielectric constant of the medium. When the aconitic acid was esterified, the anomalous effect was removed.

S. Bywater put forward a mechanism for the reduction of ferric ion by molecular acetoin and the first radical formed by their interaction, which will account for the known reduction of ferric ion by hydroxy ketones. K. E. Russel has found that it is possible to produce polymers of high molecular weight by using large diradicals formed by decomposing monometric sebacyl and azelayl peroxides in the presence of styrene monomer.

The kinetics of the photo-initiated free-radical polymerizations of methyl methacrylate in aqueous solution was described by C. C. Menon and M. Santappa in a paper read by L. Breitman. It was concluded that initiation was by OH or Cl free radicals and termination was mutual. The theory of determining particle sizes for light-scattering measurements was described by W. Heller. Preliminary data showed the usefulness of this technique in elucidating the mechanism of emulsion polymerization.

D. J. Worstold reported that, in the polymerization of α-methyl styrene by the boron trifluoride-diethyl ether complex in the presence of excess water, the rate with respect to monomer changes from second to first order as the temperature is raised. By preparing samples of varying low molecular weight, C. Sivertz was able to show a sharp drop in the ratio of chain transfer constant to propagation constant after the first addition product. F. R. Eirich discussed the mechanism of reaction when Ziegler-type catalysts are used in polymerization.

The treatment and use of polymeric intermediates have received the attention of a number of individuals recently. J. A. Parker reported the preparation of mixed carboxylic carbamic anhydrides from the reaction of aromatic isocyanates with a series of monoesters of aliphatic dibasic acids and described how these intermediates might be used as cross-linking agents for polyesters. The physical properties of castable elastomers based on polyether glycols and diisocyanates were described by L. A. Dickenson.

N. Nikolov reported the preparation of graft copolymers by ozonization of one latex, followed by addition of a second monomer. The difficulty in milling graft copolymers was attributed to branching during the ozonization step. M. L. Miller described the polymerization of acrylamide and acrylonitrile to form block polymers containing two to three long blocks and graft polymers containing one to 20 long grafts. Some properties of these were compared with those of copolymers of the same composition. M. Szwarc described how the lack of a termination step when one is dealing with an anionic polymerization in a nonproton donating solvent resulted in polymers with "living" ends. These "living" polymers make such a system particularly suited to the synthesis of block polymers.

A number of papers on the solution properties of high polymers were presented. In a study of the dilute solution viscosities of fractions of branched and linear samples of polyvinyl acetate, L. M. Hobbs reported that part of the increase in the Huggins constant K', usually associated with branching, was actually due to an effect of branching on the shear behavior. J. A. Manson disclosed that a combination of viscosity and light-scattering measurements on fractions of graft polymers, prepared by polymerizing styrene in the presence of oxidized styrene, showed that for a given molecular weight, the intrinsic viscosity, molecular size, and second virial coefficient were all lower than for linear fractions of polystyrene. Although the Huggins constant K' is sensitive to small amounts of short branching, it is not apparently affected by the presence of a few simple, linear branches. M. A. Golub reported the viscosity of natural rubber in benzene at rates of shear down to 0.3 sec^{-1}. The rapid increase in viscosity found at very low shear rates confirms the theoretical relation derived by Bueche.

B. E. Conway discussed the viscosity behavior of polyelectrolytes at low concentrations and varying shear rates. S. N. Chinai, in a study by light-scattering and viscosity of various poly-n-alkyl methacrylate, found that (i) initially the degree of flexibility of the chain increased as the size of the pendant group increased; (ii) the flexibility with n-hexyl methacrylate was much less than for any of the lower members. The effect of the hexyl group is as expected, while the result with the lower members is attributed to solvent interaction. J. J. Hermans, in a study of polyvinyl acetate in toluene, found that the apparently anomalous behavior in the relation η_{sp}/c at extreme dilution may be removed by applying the necessary corrections. The effect of shear rate persists even at the limit of infinite dilution.

M. Nakagaki presented a theory of foam formation based on the view that the foam formation of a solution is related to the energy required to remove a unit area of absorbed layer. The factors affecting foam formation of solutions of gelatin, proteins, and copolymers of vinyl acetate and vinyl alcohol are explained by this theory. D. A. I. Goring discussed the molecular weight distribution, electrophoretic heterogeneity, and polyelectrolyte behavior of lignin.

Various properties of high polymers were discussed by a number of chemists. E. B. Bagley, in a study of the flow of polyethylene through a capillary, reported a large discontinuity in the slope of the log shear rate-lot shear stress curve. This discontinuity was associated with an abrupt change from smooth to rough extrusions as the shear stress increased. The plastic flow of both low- and high-molecular-weight butadiene copolymers containing combined acid groups cross-linked with metal oxides, observed upon slowly applying stress, was discussed by E. Catterall.

A study of the birefringence of copolymers of methyl methacrylate-diallylphthalate over the complete composition range, by K. Kawata, showed that the proportionality between the stress-optical coefficient and the absolute temperature does not hold over the entire temperature range for either of the two pure polymers but does hold for an 80/20 MMA-DAP copolymer. An opti-

mum in stress-optical coefficient was observed for MMApolymer at 127°C. D. W. Saunders has found that in natural rubber and gutta-percha vulcanizates, the stress-optical coefficient is independent of the degree of cross-linking, while in polyethylene and polymethylene it decreases with increasing degree of cross-linking. A paper read by K. Kawata described how a spectrum for the secondary dispersion region of polymethyl methacrylate had been obtained and how it contained a peak and a plateau, to which different values of the activation energy could be assigned.

Two papers on the degradation of high polymers completed the program. M. V. Lock reported that, in the photo-oxidation of amylose sensitized by anthraquivoid compounds, a random attack on the polymer occurs and a multichain mechanism is in operation. The degradation may be followed by viscosity measurements. S. Bywater found that in the decomposition of poly-α-methylstyrenes the rate of thermal decomposition is first order, while the catalyzed decomposition rate is zero order with respect to polymer concentration.

R. A. STEWART
Research and Development Division, Polymer Corporation, Sarnia, Canada

World Federation for Mental Health

The ninth annual meeting of the World Federation for Mental Health held in Berlin, 12–17 Aug., had as its major theme "Mental health in home and school." The federation's true multidisciplinary nature was evident in the representation of its 104 societies from the fields of psychiatry, psychology, social work, sociology, education, and the other social sciences, and in the election of Margaret Mead, a cultural anthropologist, to the presidency.

Mead, in her opening address on "Mental health and its international implications," stressed the importance of interdisciplinary cooperation. "The concept of mental health arose from the study of mental disorders, of those human beings who, either from circumstances of individual life-history, physical defect, or as a result of dislocations in society, were disturbed in their functioning as whole human beings. Meanwhile, in those sciences concerned with the study of well human beings and of human societies, there developed a picture of the potential well-being which human beings might attain were the appropriate social and individual measures taken to insure them an upbringing and a place in society consonant with their potentialities. From the study of well children, and the study of small stable communities, and the study of well-functioning adults, it became clear that nowhere in the world, even under the best existing conditions, were we actually realizing the potentialities of human beings to live as whole persons. Meanwhile, existing conditions were steadily putting more strain on human beings, as life became more complicated and individual lives more fragmented, as individuals were born into one kind of society, and often before they were adolescent were required to adjust to another kind, and might have to live as parents and grandparents in still other forms of social life. There has been, it is true, another side to this increasing complication in the growth of scientific knowledge of human behavior, and of those disciplines —psychiatry, social work, nursing, pediatrics, modern education, community planning, and human relations in industry—designed to apply this knowledge constructively in human life. But these basic sciences and disciplines also suffered from the fragmentation of modern civilization, so that it became necessary, if we were to have a concept of wholeness for human beings, also to develop a concept of wholeness for those sciences and fields of applications which were concerned with human beings, as individuals, in families, in schools, in the community, the nation, and the world.

"This is the concept of mental health, which brings together all of the disciplines concerned with human behavior in the pursuit of a great wholeness for human beings."

The general theme of Mead's closing address was the contribution that each culture can make to the solution of present-day world problems. She stressed three different possible contributions: (i) that of North America to the development of a sense of trusteeship for the irreplaceable natural resources of the world which would have to follow the present lavish overuse of these resources; (ii) that of Israel, where out of the age-long experience of racial persecution a new level of acceptance of human beings of different physical type and cultural background is being painfully evolved; and (iii) that of Berlin, where from the tragic circumstances of devastation and fragmentation a new clarification of the differences between the contrasting political systems that now jostle each other so closely may emerge.

Eduardo Krapf, who resigned the presidency of WFMH to become chief of the Mental Health Section of the World Health Organization, reported on the relationship of the WFMH and WHO, clearly describing the close cooperation between the two agencies, with WHO taking leadership in the medical area of mental health and mental illness, in the improvement of clinical psychiatric training and treatment facilities, and WFMH becoming increasingly involved in multidisciplinary mental health activities.

Helen Ascher's report on the "Relationship of WFMH to the U.N." indicated an increasingly productive cooperative relationship. The WFMH has devoted considerable effort to studying and publicizing some of the social implications of technical assistance, including a book edited by Mead and published by UNESCO on *Cultural Patterns and Technological Change,* and a pamphlet on "The social implications of technical assistance"—a summary record of a panel discussion held by WFMH at the United Nations in April 1955. The latest development in the U.N., the new agency to deal with peaceful uses of atomic energy, has stimulated the WFMH to set up a committee of its executive board to plan how some of the fears and anxieties that will accompany the industrial revolution can be identified and allayed.

The reports of the research being carried out by WFMH also indicate its broadening interest and increasing collaborative activity with foundations, nongovernmental organizations, and U.N. specialized agencies. Research presently being undertaken includes a joint project with UNESCO on mental health and education being conducted by Cato Hambro of Oslo, Norway; a world-wide study of student mental health jointly with the Field and Grant foundations, and study of the conduct of small international conferences jointly with the Josiah Macy, Jr. Foundation, and a working conference of executives of international governmental organizations on problems of international administration, jointly with the Carnegie Endowment for International Peace.

The tenth annual meeting of WFMH will be held in Copenhagen, Denmark, in August 1957.

MOTTRAM TORRE
Faculty of Medicine, Columbia University

Darcy Centennial Symposia

The International Association of Scientific Hydrology, a constituent organization of the International Union of Geodesy and Geophysics, met in Dijon, France, 20–26 Sept. 1956. The meeting was designated the Darcy Centennial Symposia in honor of the eminent French hydraulic engineer, Henri Darcy (1803–58). His experiments on sand filtration in Dijon led to publication in 1856 of the linear relationship between velocity and hydraulic gradient, now commonly known as Darcy's law.

About 100 delegates participated in the symposia, representing 20 nations:

Austria, Belgium, Czechoslovakia, Egypt, France, Germany, Great Britain, Hungary, Israel, Italy, Japan, Morocco, the Netherlands, Poland, the Soviet Union, Spain, Switzerland, Tunisia, the United States, and Yugoslavia. Delegates from the United States included W. E. Hiatt (U.S. Weather Bureau); L. R. Beard (Corps of Engineers, U.S. Army); T. Dalrymple, L. B. Leopold, and M. I. Rorabaugh (U.S. Geological Survey); F. H. Klaer (Ranney Method Water Supplies, Inc.); V. T. Chow (University of Illinois); and D. K. Todd (University of California).

A total of 74 papers were presented with six sessions devoted to floods, six to ground-water hydrology, and one to evaporation. Papers were presented in French or English with summaries following in the alternate language. Most papers were actively discussed within the time limits available. There was considerable discussion regarding the limits of the range of validity of Darcy's law. At the upper limit distinctions were made between deviations in the linear relationship and the inception of turbulent flow within porous media. Some delegates argued that a lower limit above zero velocity could be demonstrated theoretically, while K. Ubell (Hungary) indicated that experimental studies were underway to confirm this.

The difficulties encountered in extrapolating flood frequencies are apparently international in character. Although advocates could be found for particular methods, by far the predominant sentiment was that errors involved in estimating infrequent floods made the use of such methods dangerous for design of large river-control structures. Because of the need for further study and clarification of the value of flood frequency methods, it was recommended that special sessions be devoted to the subject at the general assembly of the International Union of Geodesy and Geophysics to be held in Toronto, Canada, in September 1957.

The complete texts of papers presented at the symposia have been published in a three-volume proceedings with the help of a grant from UNESCO. Totaling 709 pages, the complete proceedings are available from L. J. Tison, General Secretary, International Association of Hydrology, 61 rue des Ronces, Gentbrugge, Belgium.

Immediately following the symposia, a 3-day excursion was arranged into southern France. About 50 delegates participated in this enjoyable trip. The itinerary included visits to a meteorological station in the Alps near Briancon, the Fournel hydroelectric plant and hydrological station near Serre Poncon, and the Pont Mirabeau hydrological station on the Durance River and a tour of the Lower Durance Valley including ground-water recharge operations at Chateaurenard.

Arrangements for the United States papers and delegates were competently handled by R. N. Wilson, hydrology program chairman of the American Geophysical Union. It was the unanimous opinion of all in attendance at Dijon that the success of the symposia could be directly attributed to the untiring efforts of Tison, who was ably assisted by his wife, son, and daughter-in-law.

DAVID K. TODD
University of California, Berkeley

Conference on Scientific Information

Preliminary plans for the International Conference on Scientific Information [*Science* **124**, 595 (28 Sept. 1956)] were reviewed and warmly endorsed by approximately 50 scientists and experts in documentation who met at the National Academy of Sciences on 11 Nov. under the chairmanship of Warren Weaver, vice president for the natural and medical sciences of the Rockefeller Foundation. Lloyd Berkner, president of Associated Universities, Inc., and president of the International Council of Scientific Unions (ICSU), represented ICSU at the meeting. Alexander King, chief scientific officer of the Intelligence Division, Department of Scientific and Industrial Research, United Kingdom, represented UNESCO and the International Federation for Documentation. Based on this group's approval of the proposed plans, the sponsors—the National Science Foundation, the American Documentation Institute, and the National Academy of Sciences–National Research Council—are now proceeding with detailed arrangements for holding the conference in Washington, D.C., early in November of 1958.

The subject matter to be covered at the conference will be grouped in the following general areas:

1) Requirements of scientists for scientific literature and reference services: knowledge now available and methods of ascertaining their requirements.

2) The function and effectiveness of abstracting and indexing services for storage and retrieval of scientific information and possible development of such services.

3) Effectiveness of scientific monographs, compendia, and specialized information centers for storage and retrieval of scientific information: survey of present practices, trends, and new and proposed techniques and types of services.

4) Organization of information for storage and retrospective search: comparative characteristics of existing systems.

5) Organization of knowledge for storage and retrospective search: conceptual and mechanical problems in the design of new systems.

6) Organization of information for storage and retrospective search: possible development of a general theory of storage and search.

7) Responsibilities of governmental bodies, professional societies, universities, and research and industrial organizations for research and training in scientific documentation and for operation of scientific information services.

Participation will be limited to specialists in the fields covered by the agenda. These will include authors of papers accepted for inclusion in the conference program and members of review panels, which are the working panels designated to lead the discussion of papers in each working area. Individuals may serve both as authors and as members of review panels, except that authors may not serve on review panels in areas covered by their own papers. In the interest of effective discussion it is believed that the number of participants must not exceed 150. (This includes authors and members of review panels.) Observers will be encouraged to attend the conference; however, they will be asked to register in advance.

Final authority for accepting papers for the program has been vested by the sponsors in a Conference Committee. This committee, through the secretariat, will call on the services of the most highly qualified experts throughout the world to referee all papers submitted. The criteria that have been adopted for papers to be included on the program are as follows:

1) Papers will deal with work that has not been published or presented at any open meeting. Work will be considered to have been published if it has been reproduced for general distribution in any form or if copies have been deposited in libraries where they are available to the public.

2) Papers will be directed to specialists in the field covered. Only sufficient background information will be included to serve as an adequate framework for new work described in the papers. More general background material will be indicated by references.

3) Papers dealing with systems and methods will describe these at length only when they have not been described previously. If new methods or systems are involved, these will be described in sufficient detail to enable other qualified workers to duplicate the procedures and the results. There will be sufficient information to enable qualified readers to judge the validity of results in objective terms.

4) Theoretical papers will clearly explain the factual basis from which theo-

retical conclusions have been drawn and will point the way to experimental methods of verifying predictions which follow from such theoretical conclusions.

Within this framework the Conference Committee invites contributions to the program from workers anywhere in the world who are interested in presenting papers in any of the areas covered by the agenda. Attendance at the conference will not be prerequisite for acceptance of an author's paper; however, efforts will be made to assist interested authors to attend.

Accepted papers will be printed and distributed to all participants at least 2 months in advance of the conference date so that they will not need to be read in their entirety at the conference. Instead, they will be presented in brief outline for discussion by review panels of experts and by all interested participants. The conference proceedings will be published in book form.

Individuals interested in submitting papers should communicate with the executive secretary as soon as possible, and in any case not later than *31 Jan. 1957*. Such communications should indicate which general area of the agenda interests the author as well as the general subject matter to be covered by the proposed paper. All requests for further information should be addressed to the executive secretary, Dr. Alberto F. Thompson, International Conference on Scientific Information, National Academy of Sciences–National Research Council, 2101 Constitution Ave., Washington 25, D.C.

Meeting Notes

■ The Western Spectroscopy Association, organized in 1953 to fill the need felt by spectroscopists in the 11 western states for regular West Coast scientific meetings concerned with advances in the broad field of spectroscopy, will hold its fourth annual 2-day conference at the University of California in Los Angeles, 24–25 Jan. The program will consist entirely of invited papers, chiefly describing frontier areas in spectroscopy; there will be ample time for discussion.

Among the subjects to be covered are relaxation mechanisms, coincidence counting, nuclear magnetic resonance techniques, and far infrared, free-radical, and shock-tube spectra. Applications will be described as well as theoretical considerations. An exhibit of spectroscopic equipment also is being planned.

All interested persons may attend this meeting. Further information can be obtained from the chairman of the association, Dr. Stanley S. Ballard, Scripps Institution of Oceanography, San Diego 52, Calif.

■ The British Society of Rheology is organizing a Conference on the Rheology of Elastomers to be held at the Rubber Producers Research Association at Welwyn Garden City, 30–31 May. Contributions are invited for this conference and intending speakers are asked to first write to the Hon. Secretary, 52, Travistock Road, Edgware, Middlesex, England.

■ The second World Metallurgical Congress will be held in Chicago, Ill., 2–8 Nov. 1957. More than 500 metal scientists from approximately 35 nations are expected. Already reservations have been received from 263 conferees in 27 countries. Advance registrations from England number 45; Germany is next with 39.

The first world congress on metals and metals processing and fabrication was held in Detroit in 1951. Staged in conjunction with the National Metal Exposition and Congress, it had an attendance well over 35,000. Of this group, 550 were metal engineers from 33 foreign countries.

A series of special industrial plant tours and a week of technical discussions on metal working operations will constitute the congress program. The 39th annual National Metal Exposition and Congress will be held at the same time as the world gathering.

Society Elections

■ Soil Conservation Society of America: pres., J. S. Russell, farm editor, *Register and Tribune*, Des Moines; 1st v. pres., Russell G. Hill, Michigan State College; 2nd v. pres., J. K. Vessey, U.S. Forest Service; treas., Howard F. Barrows, Austin-Western Works, Aurora, Ill.; exec.-sec., H. Wayne Pritchard, 838 Fifth Ave., Des Moines, Iowa.

■ New Mexico Academy of Science: pres., B. K. Graham, Artesia High School; v. pres., Edward G. Damon, Alamogorda High School; sec.-treas., William J. Koster, Department of Biology, University of New Mexico.

■ Kresge-Hooker Science Library Associates: pres., Thomas A. Boyd (retired), General Motors Corporation; v. pres., Sereck H. Fox, R. P. Scherer Corporation; sec.-treas., Icie Macy Hoobler, Merrill-Palmer School, Detroit 2; exec.-sec., Wendell H. Powers, Wayne State University.

■ American Academy for Cerebral Palsy: pres., Nicholson J. Eastman, Johns Hopkins Hospital; pres.-elect, William T. Green; sec.-treas., Raymond R. Rembolt, Iowa Hospital-School, State University of Iowa, Iowa City, Ia.

■ Mississippi Valley Medical Society: pres., George E. Kirby; pres.-elect, Joseph C. Edwards; sec.-treas., Harold Swanberg, 209–244 W.C.U. Building, Quincy, Ill.; asst. sec.-treas., Jacob Reisch, Springfield, Ill. The vice presidents are John R. Wolff, Chicago; Arthur F. Fritchen, Decorah, Ia.; William P. Callahan, Wichita, Kan.; Waltman Walters, Rochester, Minn.; Walter T. Gunn, St. Louis, Mo.; George W. Covey, Lincoln, Neb.; R. H. Waldschmidt, Bismarck, N.D.; Roland G. Mayer, Aberdeen, S.D.; and Arnold S. Jackson, Madison, Wis.

■ American Society for Engineering Education: pres., W. L. Everitt, University of Illinois; sec., W. Leighton Collins, University of Illinois; treas., John Gammell, Allis-Chalmers Manufacturing Company, Milwaukee, Wis. The vice presidents are F. C. Lindvall, C. A. Brown, W. T. Alexander, and R. J. Woodrow.

Forthcoming Events

January

7–11. **International Social Science Council, 3rd gen'l. assembly, Paris, France. (Secretary Gen'l., ISSC, 19, avenue Kieber, Paris 16.)**

10. **Technical and Clinical Applications of Radioisotopes, Assoc. of Vitamin Chemists, Chicago, Ill. (M. Freed, Dawe's Laboratories, Inc., 4800 S. Richmond St., Chicago 32.)**

10–12. **American Group Psychotherapy Assoc., 14th annual, New York, N.Y. (C. Beukenkamp, Jr., AGPA, Room 300, 345 E. 46 St., New York 17.)**

14–16. **Cottonseed Processing as Related to the Nutritive Value of the Meal, 4th conf., New Orleans, La. (Southern Regional Research Lab., USDA, 1100 Robert E. Lee Blvd., New Orleans 19.)**

14–16. **Reliability and Quality Control in Electronics, 3rd natl. symp., Washington, D.C. (C. M. Ryerson, Radio Corp. of America, Bldg. 10–6, Camden 2, N.J.)**

14–18. **Society of Automotive Engineers, annual, Detroit, Mich. (Meetings Div., SAE, 29 W. 39 St., New York 18.)**

14–20. **Indian Science Cong. Assoc., 44th meeting, Calcutta, India. (General Secretary, ISCA, 1 Park St., Calcutta 16.)**

15. **Society for Applied Spectroscopy, Philadelphia, Pa. (F. M. Biffen, Johns-Manville Research Center, Manville, N.J.)**

16–23. **Australian and New Zealand Assoc. for the Advancement of Science, 32nd meeting, Dunedin, N.Z. (J. R. A. McMillan, ANZAAS, Science House, 157 Gloucester St., Sydney, N.S.W., Australia.)**

17. **Constructive Medicine in Aging: Cardiovascular Disorders in the Aged, symp., Cincinnati, Ohio. (J. B. Chewning, Wm. S. Merrell Co., Cincinnati 15.)**

17–18. **Engineers Joint Council, New York, N.Y. (EJC, 29 W. 39 St., New York 18.)**

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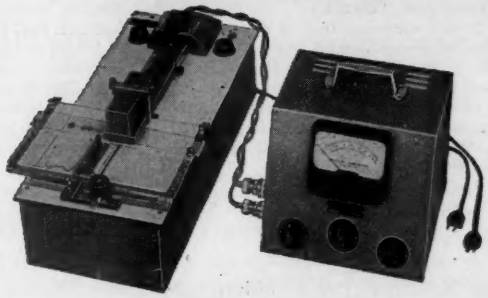

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18–19. **Symposium on Blood, 6th annual, Detroit, Mich. (W. H. Seegers, Wayne State Univ. Coll. of Medicine, Detroit 7.)**

21–22. **Solar Furnace Design and Operation, Phoenix, Ariz. (J. I. Yellott, Assoc. for Applied Solar Energy, 3424 N. Central Ave., Phoenix.)**

21–25. **American Inst. of Electrical Engineers, winter general, New York, N.Y. (N. S. Hibshman, AIEE, 39 W. 39 St., New York 18.)**

23–25. **Very Low Frequency Electromagnetic Waves, symp., Boulder, Colo. (J. R. Wait, National Bureau of Standards, Boulder.)**

24–25. **Western Spectroscopy Assoc., 4th annual, Los Angeles, Calif. (S. S. Ballard, Scripps Inst. of Oceanography, San Diego 52, Calif.)**

25. **Bibliographical Soc. of America, New York, N.Y. (H. W. Liebert, Yale Univ. Library, New Haven, Conn.)**

25–26. **Protein Metabolism, 13th annual conf., New Brunswick, N.J. (W. H. Cole, Rutgers Univ., New Brunswick, N.J.)**

28–29. **Many Body Problem, symp., Hoboken, N.J. (G. J. Yevick, Dept. of Physics, Stevens Inst. of Technology, Hoboken.)**

28–31. **American Meteorological Soc., New York, N.Y. (K. C. Spengler, AMS, 3 Joy St., Boston 8, Mass.)**

28–31. **Modern Methods of Analytical Chemistry, 10th annual symp., Baton Rouge, La. (P. W. West, Louisiana State University, Baton Rouge.)**

30–1. **American Assoc. of Physics Teachers, New York, N.Y. (F. Verbrugge, Carleton College, Northfield, Minn.)**

30–2. **American Physical Soc., annual, New York, N.Y. (K. K. Darrow, APS, Columbia Univ., New York 27.)**

30–31. **College-Industry Conf., 9th annual, American Soc. for Engineering Education, Los Angeles, Calif. (Univ. of California Extension, Engineering, Los Angeles 24.)**

31–1. **Digital Computing in the Aircraft - Industry, NYU–IBM symposium, New York, N.Y. (M. Woodbury, New York Univ., Research Div., 401 W. 205 St., New York, N.Y.)**

31–2. **Western Soc. for Clinical Research, 10th annual, Carmel-by-the-Sea, Calif. (A. J. Seaman, WSCR, Univ. of Oregon Medical School, Portland 1.)**

February

3. **American Assoc. of Bioanalysts, 3rd annual Margaret Beattie Lecture, San Francisco, Calif. (W. N. Reich, Walnut Creek-Lafayette, Laboratories, 1625 Locust St., Walnut Creek, Calif.)**

4–8. **American Soc. for Testing Materials, Philadelphia, Pa. (R. J. Painter, ASTM, 1916 Race St., Philadelphia 3.)**

10–12. **Canadian Ceramic Soc., 55th annual, Niagara Falls, Ont., Canada. (L. C. Keith, 49 Turner Road, Toronto, Ont.)**

14. **Present Status of Heart Sound Production and Recording, symp., Buffalo, N.Y. (R. M. Kohn, Univ. of Buffalo, 2183 Main Street, Buffalo 14, N.Y.)**

14. **Significance of Nucleic Acid Derivatives in Nutrition, Assoc. of Vitamin Chemists, Chicago, Ill. (M. Freed, Dawe's Laboratories, Inc., 4800 S. Richmond St., Chicago 32.)**

14–15. **Transistor Circuits, conf., Philadelphia, Pa. (G. H. Royer, Westinghouse Electric Corp., 356 Collins Ave., Pittsburgh 6, Pa.)**

15–16. **National Soc. of Professional Engineers, Charleston, S.C. (P. H. Robbins, 2029 K St., NW, Washington 6.)**

15–17. **National Assoc. for Research in Science Teaching, annual, Atlantic City, N.J. (C. M. Pruitt, Univ. of Tampa, Tampa, Fla.)**

18–20. **American Educational Research Assoc., annual, Atlantic City, N. J. (F. W. Hubbard, AERA, 1201 16 St., NW, Washington 6.)**

18–22. **American Soc. of Civil Engineers, Jackson, Miss. (W. H. Wisely, ASCE, 33 W. 39 St., New York 18.)**

18–22. **Endocrinology: Hormones in Blood, Ciba Found. Colloq. (by invitation), London, England. (G. E. W. Wolstenholme, 41 Portland Place, London, W.1.)**

21–23. **National Soc. of College Teachers of Education, annual, Chicago, Ill. (C. A. Eggertsen, School of Education, Univ. of Michigan, Ann Arbor.)**

23. **American Mathematical Soc., New Haven, Conn. (J. H. Curtiss, AMS, 190 Hope St., Providence 6, R.I.)**

23. **Oregon Acad. of Science, annual, Monmouth, (F. A. Gilfillan, Oregon State College, Corvallis.)**

24–28. **American Inst. of Mining, Metallurgical and Petroleum Engineers, annual, New Orleans, La. (E. O. Kirkendall, AIME, 29 W. 39 St., New York 18.)**

24–28. **International College of Surgeons, 10th biennial cong., Mexico, D.F., Mexico. (M. Thorek, ICS, 850 W. Irving Park Rd., Chicago 13, Ill.)**

25–28. **American Soc. of Heating and Air-Conditioning Engineers, Chicago, Ill. (A. V. Hutchinson, ASHAE, 62 Worth St., New York 13.)**

26–28. **Western Joint Computer Conf., Los Angeles, Calif. (M. J. Mendelson, Norden-Ketay Corp., 13210 Crenshaw Blvd., Gardena, Calif.)**

March

1–2. **American Physical Soc., Norman, Okla. (K. K. Darrow, Columbia Univ., New York 27.)**

1–3. **National Wildlife Federation, annual, Washington, D.C. (C. H. Callison, 232 Carroll St., NW, Washington 12.)**

3–6. **American Inst. of Chemical Engineers, White Sulphur Springs, W.Va. (F. J. Van Antwerpen, AIChE, 25 W. 45 St., New York 36.)**

3–9. **American Soc. of Photogrammetry, 23rd annual, joint with American Cong. on Surveying and Mapping, 17th annual, Washington, D.C. (C. E. Palmer, ASP, 1515 Massachusetts Ave., NW, Washington 5.)**

4. **Wildlife Soc., annual, Washington, D.C. (D. L. Leedy, Fish and Wildlife Service, Dept. of the Interior, Washington 25.)**

4–6. **National Biophysics Conf., Columbus, Ohio. (H. P. Schwan, School of Medicine, Univ. of Pennsylvania, Philadelphia 4.)**

4–8. **Analytical Chemistry and Applied Spectroscopy, Pittsburgh, Pa. (L. M. Melnick, U.S. Steel Corp., Applied Research Lab., Monroeville, Pa.)**

7–9. **Fundamental Cancer Research, 11th annual symp., Houston, Tex. (L. Dmochowski, M. D. Anderson Hospital, Texas Medical Center, Houston 25.)**

7–9. **Optical Soc. of America, semiannual, New York, N.Y. (A. C. Hardy, Massachusetts Inst. of Technology, Cambridge 39.)**

10–16. **Nuclear Engineering and Science Cong., 2nd, Philadelphia, Pa. (Engineers Joint Council, 29 W. 39 St., New York 18.)**

11–15. **National Assoc. of Corrosion Engineers, 13th annual, St. Louis, Mo. (Secretary, NACE, Southern Standard Bldg., Houston 2, Tex.)**

13–15. **Society of Exploration Geophysicists, 10th annual midwestern, Fort Worth, Tex. (G. A. Grimm, Tide Water Associated Oil Co., Box 2131, Midland, Tex.)**

14. **Effect of Radiation on Foods, Assoc. of Vitamin Chemists, Chicago, Ill. (M. Freed, Dawe's Laboratories, Inc., 4800 S. Richmond St., Chicago 32.)**

18–21. **Institute of Radio Engineers, natl. convention, New York, N.Y. (B. Warriner, IRE, 1 E. 79 St., New York 21.)**

19–21. **American Meteorological Soc., 151st national, Chicago, Ill. (K. C. Spengler, AMS, 3 Joy St., Boston 8, Mass.)**

20–22. **National Health Forum, Cincinnati, Ohio. (National Health Council, 1790 Broadway, New York 19.)**

20–23. **National Science Teachers Assoc., annual, Cleveland, Ohio. (R. H. Carleton, NSTA, 1201 16 St., NW, Washington 6.)**

21–23. **American Physical Soc., Philadelphia, Pa. (K. K. Darrow, APS, Columbia Univ., New York 27, N.Y.)**

21–23. **International Assoc. for Dental Research, annual, Atlantic City, N.J. (D. Y. Burrill, 129 E. Broadway, Louisville 2, Ky.)**

21–23. **Michigan Acad. of Science, Arts and Letters, annual, Detroit, Mich. (R. F. Haugh, Dept. of English, Univ. of Michigan, Ann Arbor.)**

24–27. **American Assoc. of Dental Schools, annual, Atlantic City, N.J. (M. W. McCrea, 42 S. Greene St., Baltimore 1, Md.)**

25–27. **American Soc. of Tool Engineers, 25th annual, Houston, Tex. (R. Gebers, 10700 Puritan, Detroit 38, Mich.)**

25–28. **American Acad. of General Practice, 9th annual scientific assembly, St. Louis, Mo. (M. F. Cahal, AAGP, Volker Blvd. at Brookside, Kansas City 12, Mo.)**

26–28. **Mechanisms for the Development of Drug Resistance in Microorganisms, Ciba Foundation Symp. (by invitation), London, England. (G. E. W. Wolstenholme, 41 Portland Pl., London, W.1.)**

EQUIPMENT NEWS

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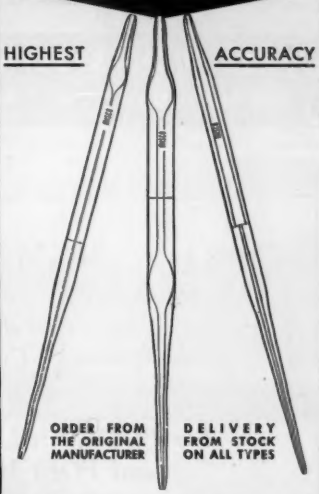

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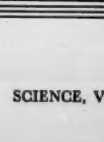

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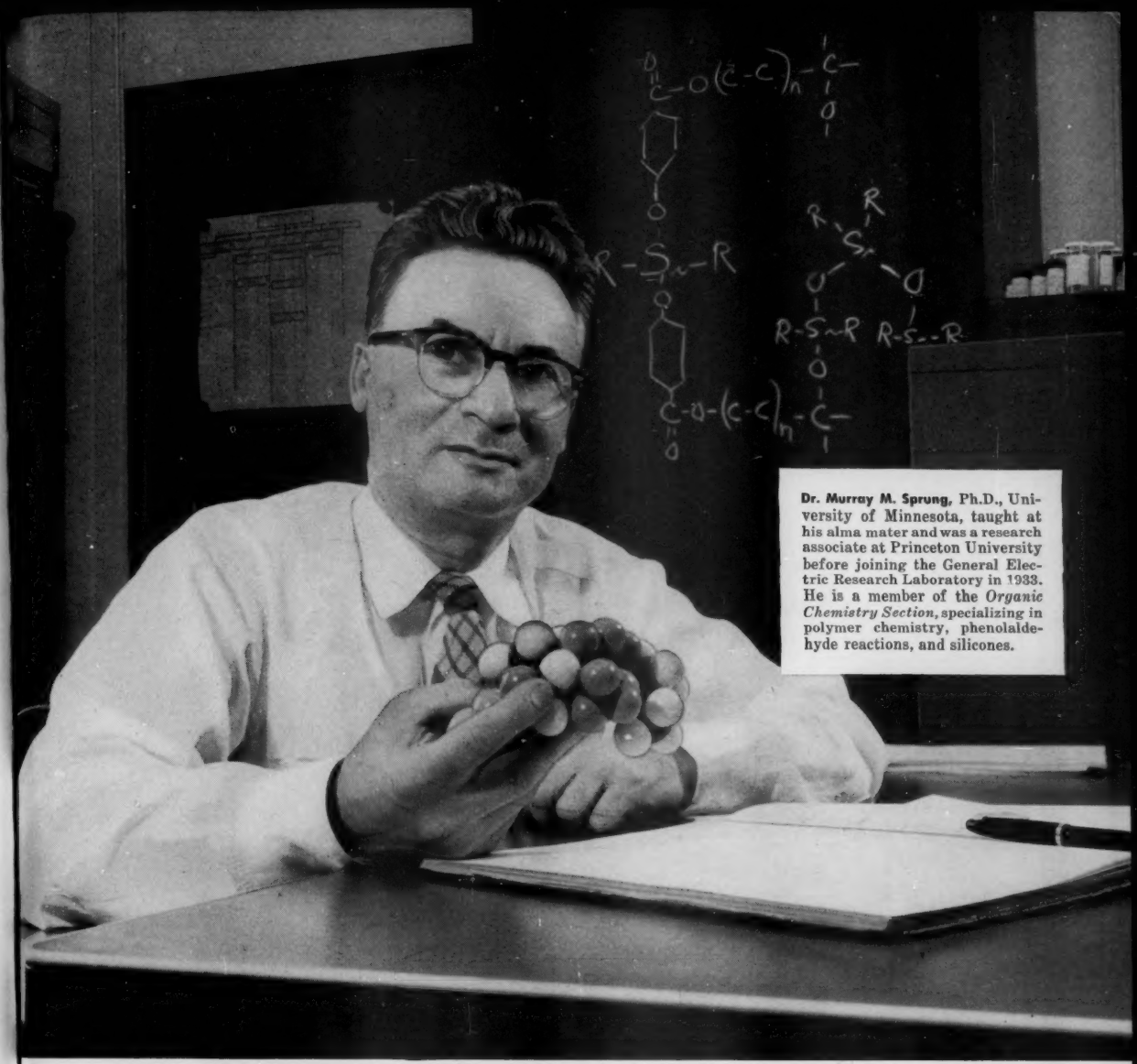

Dr. Murray M. Sprung, Ph.D., University of Minnesota, taught at his alma mater and was a research associate at Princeton University before joining the General Electric Research Laboratory in 1933. He is a member of the *Organic Chemistry Section,* specializing in polymer chemistry, phenolaldehyde reactions, and silicones.

Product progress through creative chemistry

General Electric's Dr. Murray M. Sprung designs polymers

The *creative chemist* seeks knowledge from which he—or others—can build new materials. Among the aims of the creative chemist are the design and synthesis of specific structures in which requirements such as strength, elasticity, heat resistance, and insulating properties are carefully balanced.

Man-made materials—particularly plastics—have come into their own during the past few years, and one of the chemists who have made key contributions is Dr. Murray M. Sprung of the General Electric Research Laboratory.

Dr. Sprung's studies of phenolics, vinyls, and other polymers have been reflected in greatly improved insulating materials for electrical equipment. His early and continuing work in silicones has helped in the creation of entirely new products which today are widely used both in industry and the home.

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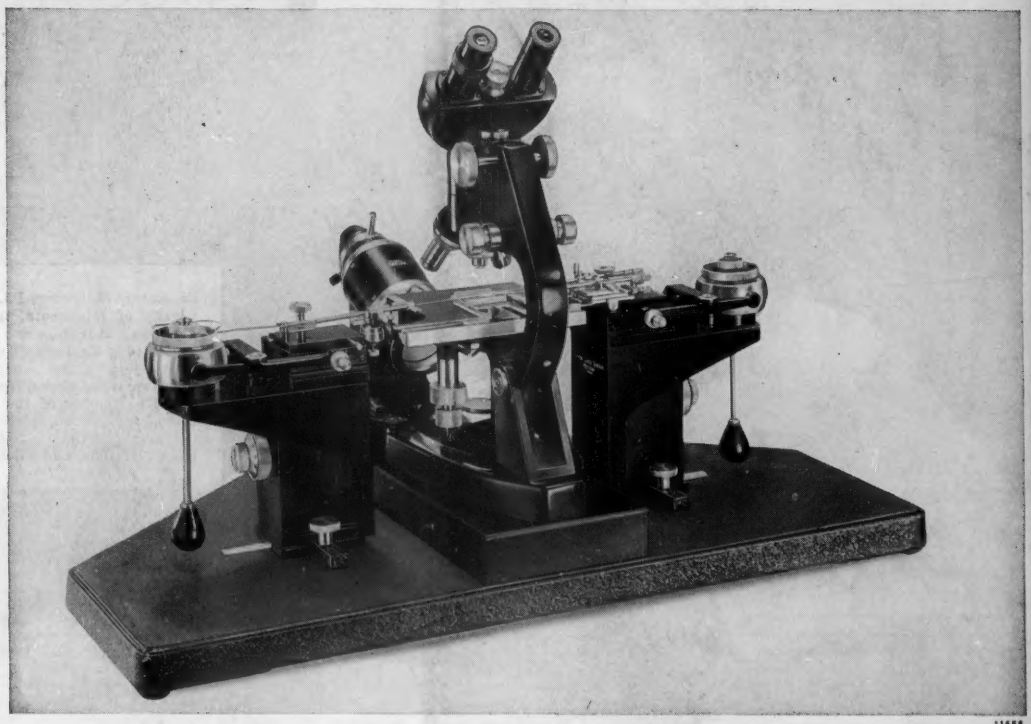

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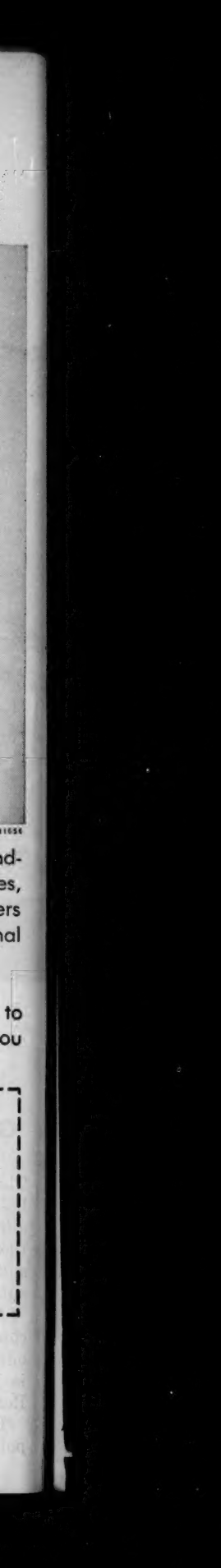
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